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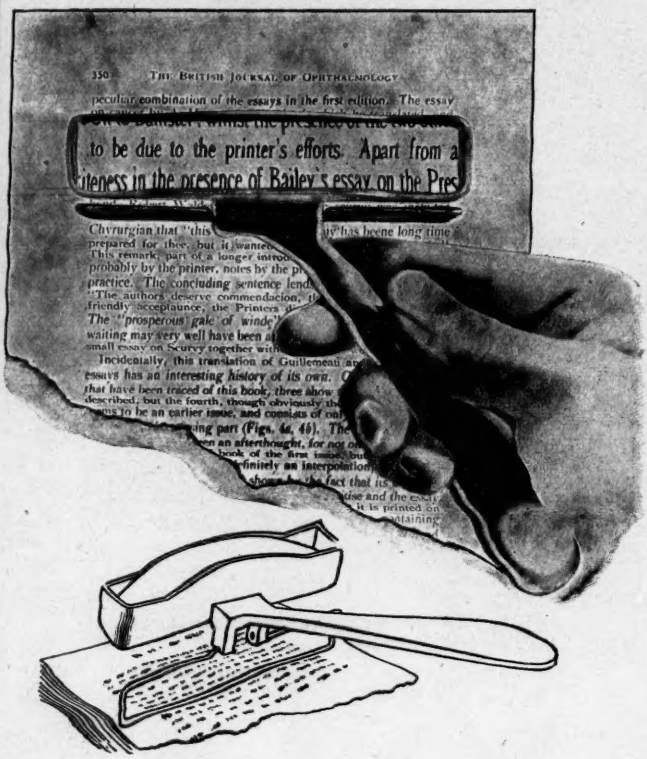

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Brit. J. Ophthal. (1954) **38**, 129.

COMMUNICATIONS

VARIATIONS IN THE EPISCLERAL VENOUS PRESSURE IN RELATION TO GLAUCOMA*

BY

W. E. S. BAIN

Institute of Ophthalmology, University of London. Director of Research, Sir Stewart Duke-Elder

THOMASSEN (1947, 1948, 1949) was the first to try to relate variations in the episcleral venous pressure to the phasic variations of intra-ocular pressure in the human eye. In view of the fundamental importance of his observations it was decided to confirm and perhaps to extend them.

Method

A perspex chamber having a thin rubber diaphragm opposite an observation window was constructed (Fig. 1*a*). This chamber was connected with a seamless metal bellows which altered the pressure in the chamber by means of a screw thread. The bellows was also connected with a U-shaped water manometer calibrated in centimetres (Fig. 1*b*). The screw thread actuating the bellows was of such a pitch as to allow of minute variations in the pressure in the system. The chamber and bellows were filled with air.

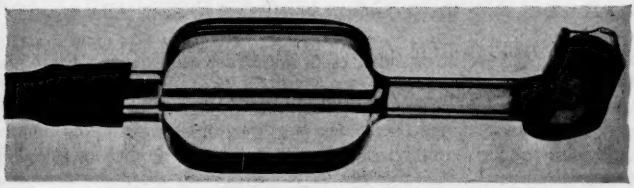

FIG. 1 (*a*).—Pressure chamber.

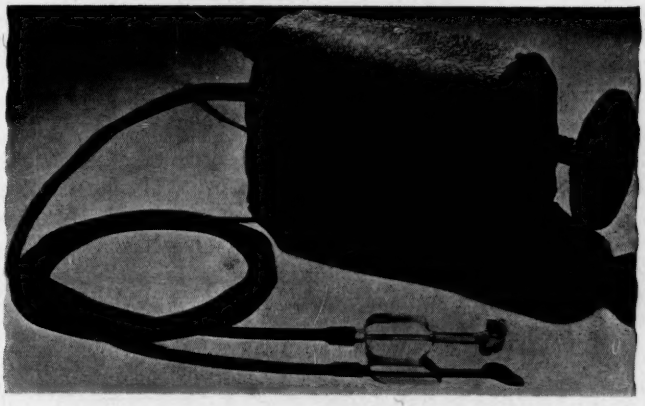

FIG. 1 (*b*).—Pump and pressure chamber.

The end of the chamber carrying the diaphragm was supported by three small legs, which rested on the globe and formed a steady base from which the vein under observation

*Received for publication December 12, 1953.

was compressed. It was found that the fine rubber diaphragm, dry on one side and wet with tear fluid on the other, was perfectly transparent.

In selecting veins for observation, it was found that those lateral to the cornea were the most convenient; the chamber, though small, is bulky enough to make other parts of the sclera less accessible. At first veins were sought which could be seen to emerge from the depths of the sclera, and observations were made as far as possible before they branched. In the course of the investigation, however, it was found that this was less important than at first thought, and that variations in pressure could be detected in most of the episcleral veins near the limbus. Serial observations were confined to the same site on the same vein in all cases.

The method has several limitations. First, while some patients tolerated repeated observations very well, a few complained of, and showed signs of, local conjunctival irritation. Second, some subjects showed no suitable vein for taking readings, either because there were few veins in the convenient area mentioned above, or because those available showed variations of low tension so small that they were impossible to record. Presumably in such cases there had been so much branching in the scleral plexus that pressure variations had been ironed out before the vein came into the field of observation.

It was found in some cases that the point of obliteration of a vein did not always coincide with the point of re-filling. Thus, on increasing the pressure in the chamber, a vein might empty at a certain pressure-level, but on lowering the pressure slightly it was found that the vein did not always re-fill with blood at the level at which it had emptied. Therefore in all cases the end-point was taken to be the level of pressure that just allowed the first fine thread of blood to pass along the vein. This was found to be constant in the same eye within 2 cm. of water pressure for consecutive readings.

In all, forty patients out of some sixty examined were found to have suitable veins in the most convenient site.

The readings of venous pressure in centimetres of water are recorded on the graphs that follow. It should be emphasized that these readings are not absolute pressures; the three legs on the end of the pressure chamber hold the rubber diaphragm a fraction of a millimetre away from the eye, so that a small degree of the pressure within the chamber is used up in bringing the rubber diaphragm into contact with the surface of the globe. The amount of pressure required to do this naturally varies with the curvature of the sclera, and with the site chosen for the observations.

In general it will be noted that the readings are of the order of venous pressure recorded by other observers, except that the highest ones are lower than Thomassen's highest readings.

Normal Findings

(1) *Phasic Variations.*—Fig. 2 shows superimposed venous pressure and intra-ocular pressure curves in a normal eye. The curves of the intra-ocular pressure were found, in general, to follow the curves of the venous pressure, and the changes in the latter to precede those in the former. This is in accordance with Thomassen's findings, and in this series was a feature common to both congestive and simple glaucoma.

Figs 3 and 4 show the superimposed curves of intra-ocular and venous pressure in the right eye of two cases of simple glaucoma. Fig. 5 shows clearly the same feature; here in addition, the curves for both eyes have been superimposed and it will be noticed that the venous pressure shows almost the same variation for the two eyes. The intra-ocular pressure of the right eye reaches a markedly greater height than that of the left. In this case, clinically,

the tension of the right eye was barely controlled by miotics and the field to 2/2000 mm. white was reduced to 10°. The left eye had a full field to 2/2000 mm. white, but a strongly positive water-drinking test; it was symptom-free.

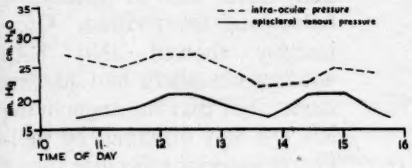

FIG. 2.—Normal.

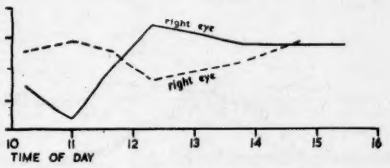

FIG. 3.—Simple glaucoma.

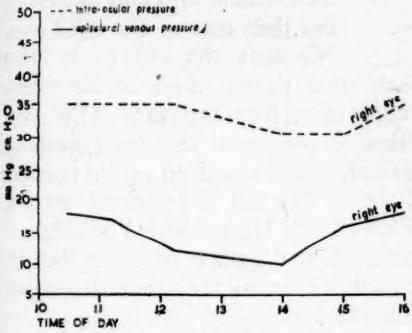

FIG. 4.—Simple glaucoma.

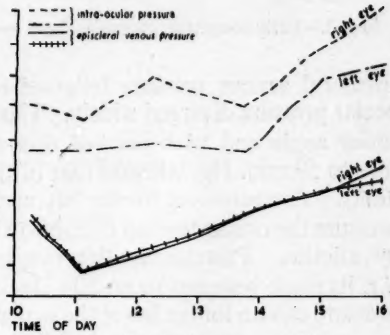

FIG. 5.—Simple glaucoma, both eyes.

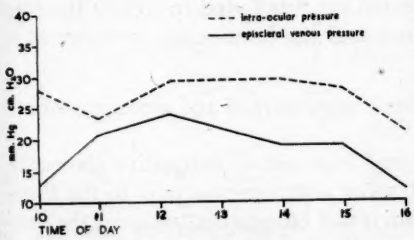

FIG. 6.—Congestive glaucoma.

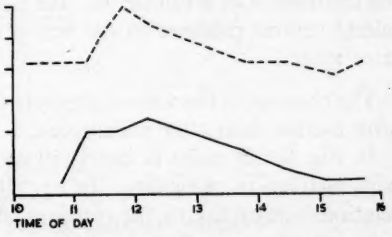

FIG. 7.—Congestive glaucoma.

Figs 6 and 7 show the relationship between episcleral venous pressure and intra-ocular pressure in two subjects with congestive glaucoma.

In addition to this time-relationship for individual eyes it was found that the curves for the episcleral venous pressure of each eye of the same subject showed the same features, provided that veins could be found in each eye which were similar in size, and which could be observed at a similar distance from their exit from the sclera. In the case shown in Fig. 5 both eyes were glaucomatous, the right eye much more advanced than the left as described above. Fig. 8 (overleaf) shows a case of early congestive glaucoma in the left

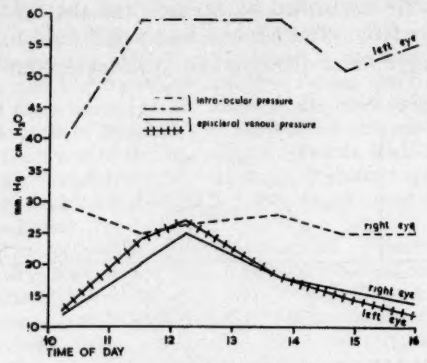

FIG. 8.—Early congestive glaucoma, both eyes.

eye. There was no cupping of either optic disc and the visual fields were full. The dark-room test was positive in the left eye, and there was a history of haloes and misty vision. Gonioscopy showed that both anterior chambers had narrow angles, but that the angle in the left eye was obscured by peripheral anterior synechiae round one quarter of the circumference, the overall width being markedly less than that of the right eye. Whereas the curves of the episcleral venous pressure followed each other closely, those of the intra-ocular pressure diverged widely. The curve taken from the eye with the narrower angle and with marked formation of peripheral anterior synechiae rose to 59 mm. Hg, whereas that of the normal eye remained within normal limits. Furthermore, in the left eye, despite the fall in episcleral venous pressure the ocular tension remained above 50 mm. Hg and had to be reduced by miotics. Presumably this eye has such a defective filtration system (*i.e.* its angle becomes so readily blocked) that lowering the episcleral venous pressure can no longer lower the ocular tension.

(2) *Effect of Miotics.*—In patients with either simple or congestive glaucoma the instillation of a miotic into the affected eye was found to reduce the episcleral venous pressure in the first place, and the intra-ocular pressure at a later stage.

The changes in the venous pressure were more marked and more immediate after eserine than after pilocarpine.

In Fig. 9 this point is clearly illustrated in a case of congestive glaucoma with instillation of eserine. In Fig. 10 more attention was paid to the time-relationships on taking the readings, and it will be seen that whereas the venous pressure was affected within 5 min., the intra-ocular pressure did not show any demonstrable fall for 15 to 20 min.

Fig. 11 shows the curves in a case of absolute glaucoma; here, as might be expected, the eye showed complete peripheral anterior synechiae, and although there was a significant fall in episcleral venous pressure on exhibiting eserine, the intra-ocular pressure was unaffected. Again, as in the case shown in Fig. 8, abnormalities of structure caused a departure from the basic physiology.

The instillation of pilocarpine showed similar results; a typical curve for an early case of congestive glaucoma is shown in Fig. 12, and one for a more

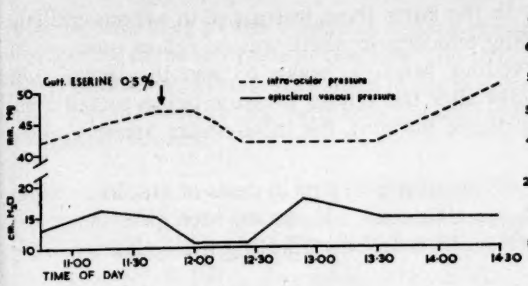

FIG. 9.—Congestive glaucoma.

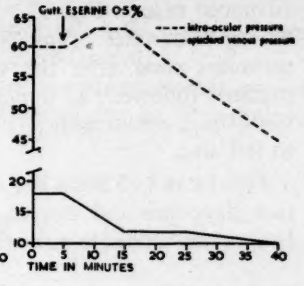

FIG. 10.—Congestive glaucoma.

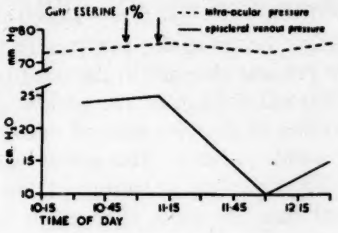

FIG. 11.—Absolute glaucoma.

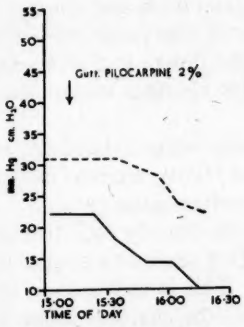

FIG. 12.—Early congestive glaucoma.

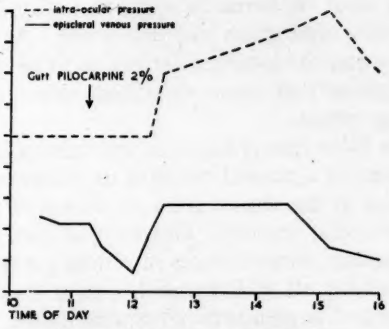

FIG. 13.—Advanced congestive glaucoma.

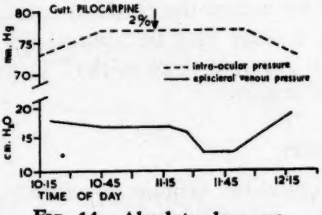

FIG. 14.—Absolute glaucoma.

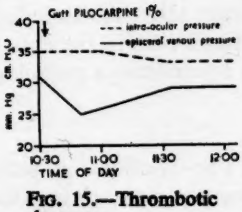

FIG. 15.—Thrombotic glaucoma.

advanced case in Fig. 13. In the latter there was a rise in venous pressure within 40 minutes of instilling pilocarpine; there was no fall in intra-ocular pressure; soon after the venous pressure began to rise the intra-ocular pressure followed; 40 minutes after the venous pressure began to fall again (following, presumably, its phasic pattern), the intra-ocular pressure began to fall also.

Figs 14 and 15 show the effects of pilocarpine in cases of absolute congestive glaucoma and thrombotic glaucoma. It can be seen that the miotic lowers the venous pressure without markedly affecting the ocular tension.

Discussion

Two points seem to emerge from this investigation:

(1) Measurable changes occur in the pressure in the episcleral veins and these can be shown to precede changes in the intra-ocular pressure, whether these are due to the diurnal rhythm of the patient or to drugs.

(2) In comparable veins in the two eyes of one subject variations in the pressure follow a very similar pattern. This agrees with the findings of Dobree (1953), who studied the variations in calibre of the episcleral veins photographically, and stated that the same changes in calibre take place in the veins of each eye.

The recorded variations of venous pressure in this series are not large, but it must be borne in mind that they are taken from the episcleral veins after their emergence from the sclera. As a result, the pressures will tend to be low and the pressure variations to be damped down, and it is reasonable to suppose that these variations reflect greater changes within the ciliary venous plexus.

The facts that changes in the venous pressure occur bilaterally, and are the same in a normal eye as in its glaucomatous fellow, seem to indicate that changes in the venous pressure do not of themselves cause pathological rises in the ocular tension. However, in eyes with an already defective drainage mechanism, these changes in venous pressure may serve as a trigger mechanism, setting off an irreversible rise in tension. This is well seen in the cases of congestive glaucoma illustrated above, where the chamber angle is partly obstructed by peripheral anterior synechiae.

In simple glaucoma, rises and falls of ocular tension are preceded by similar changes in the venous pressure, and if we accept the classical concept of a trabecular sclerosis hindering drainage, a stage may be reached when even quite small rises in the episcleral venous pressure serve as the " last straw " which precipitates a pathological rise in tension.

Summary

(1) The relationship between the episcleral venous pressure and the intra-ocular pressure has been studied.

(2) Changes in the episcleral venous pressure generally seem to precede changes in the intra-ocular pressure, and to occur bilaterally.

(3) It is suggested that changes in the episcleral venous pressure in eyes with defective structure (*e.g.* peripheral anterior synechiae) may set off pathological rises in tension.

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Brit. J. Ophthal. (1954) **38**, 136.

GONIOSCOPIC STUDIES IN CONGESTIVE GLAUCOMA*

BY

REDMOND SMITH

From the Institute of Ophthalmology, London. Director of Research, Sir Stewart Duke-Elder

SINCE narrow-angle glaucoma was described by Barkan (1938), conflicting opinions have been expressed as to the correctness of his views. Barkan postulated, and many authors have since agreed with him, that the rise in intra-ocular pressure in the condition usually known as congestive glaucoma, is due to mechanical obstruction to the outflow of aqueous at the filtration angle of the anterior chamber by the apposition of the periphery of the iris to the corneo-scleral trabeculae or to the cornea just anteriorly (Sugar, 1941; Haas and Scheie, 1952; Chandler, 1952). These authors believe that the anatomical configuration of the eye predisposes to this event and do not admit that the pre-existing shallowness of the anterior chamber has a dynamic pathological cause. Moreover, Rosengren (1950) has produced evidence to show that the depth of the anterior chamber in patients with congestive glaucoma does not vary appreciably if measurements are made before, during, or after an acute attack.

Priestley-Smith (1883) showed that the lens increases in size with age, and Törnquist (1953) in a careful study, presented convincing evidence that shallowness of the anterior chamber *per se* may be an inherited characteristic. He also showed that the depth of the anterior chamber in relatives of persons known to have congestive glaucoma tends to be significantly less than in that of the general population.

Although the relationship may not be precise, it is the opinion of the present author, as the result of gonioscopic studies, that shallowness of the anterior chamber is associated with a narrow filtration angle.

There appear to be three schools of thought regarding the mechanism of the rise in intra-ocular pressure in congestive glaucoma. The adherents of the narrow-angle theory are of the opinion that the actual closure of the filtration angle is the result of some physiological event which only produces a pathological result (the rise in intra-ocular pressure) because of the pre-existing anatomical condition of narrowness of the angle. Various suggestions have been made as to the exact mechanism involved; Chandler (1952) and Haas and Scheie (1952) postulated a slight peripheral ballooning of the basal portion of the iris caused by a relatively higher hydrostatic pressure in the posterior chamber over that in the anterior chamber, the so-called physiological iris bombé. Barkan in his original paper suggested a bunching of the base of the iris due to pupillary dilatation, and Sugar quoted a number of factors which

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may influence the state of the angle, such as emotion, darkness, the use of mydriatics, head injury, and acute rhinitis. Posner (1952) suggested that an element of suction of the base of the iris towards the trabeculae occurs when the sinus of the angle is secluded from the rest of the anterior chamber by apposition of the iris to the cornea in the region of Schwalbe's line.

The second school of thought comprises those authors who, while admitting that the occurrence of a raised intra-ocular pressure in this disease is due to blockage of the filtration angle by the iris, believe that the movement of the base of the iris necessary to achieve this has a dynamic pathological cause. Friedenwald (1930) observed that swelling of the ciliary body occurred in acute glaucoma and produced evidence suggesting that it may be associated with the release of a histamine-like substance in the posterior chamber. François (1948) agreed that closure of the angle was the cause of the rise in pressure, but thought it to be due to a pathological event, possibly a neuro-vascular upset. Kleinert (1953) put forward the original view that a vascular dysfunction of the small vessels near Schlemm's canal may cause swelling of the trabeculae which move inwards to become applied to the base of the iris.

The third school of thought includes those authors who believe that in congestive glaucoma the intra-ocular pressure rises before closure of the angle takes place. Duke-Elder (1952) has pointed out that phasic variations in intra-ocular pressure of a pathological magnitude may occur in these cases in the presence of an open angle. Troncoso (1948) followed the evolution of an acute glaucomatous attack and found the angle to be open in the early stages. Weinstein (1953) described a case which showed a rise in tension from 20 to 80 mm. Hg in the dark without gonioscopic evidence of closure of the angle. He repeated the experiment after a retrobulbar injection of a local anaesthetic and although the tension on this occasion did not rise at all, the gonioscopic appearances remained unchanged.

Ross (1953), on the other hand, conducted gonioscopic examinations in association with the dark-room test, and claimed that angle-closure did occur in the eye in which the tension rose. In one eye, however, in spite of an apparent closure of the angle, the pressure remained normal. He found that by shining a light into the other eye a consensual pupillary constriction occurred in the eye under examination, enabling him to see that the angle was in fact open.

All authors seem to be agreed that in the fully established state of acute congestive glaucoma, angle-closure is probably present; the disagreement hinges on the mechanism of the minor rises in intra-ocular pressure which may precede, sometimes recurring regularly for years, the true acute attack.

Miller (1953) has shown that a difference exists in the timing and steepness of the rise in tension and the suddenness of the fall between periods of raised pressure in congestive glaucoma and phasic variations in the intra-ocular pressure in normal eyes and in eyes with glaucoma simplex. He raises the question whether there is a different mechanism at work in the two types of phasic variation.

Aim of Present Investigation

The following investigation was undertaken to see if any information of value could be obtained by the gonioscopic examination of cases of congestive glaucoma, relating the gonioscopic appearances to the level of the intra-ocular pressure.

The patients were all attending the Glaucoma Clinic at the Institute of Ophthalmology, London, and all were believed to be true cases of congestive glaucoma. The diagnosis was based on the presence of a narrow angle, sharp episodic rises in intra-ocular pressure, frequently a history of haloes, and a positive response to the dark-room test. Cupping of the optic disc and field changes were not regarded as excluding the diagnosis.

Method of Examination

The patients were deprived of their usual miotic for 24 or in some cases 48 hours before the examination. Readings were taken with the Schiötz, or in some cases with the electronic, tonometer, and gonioscopy was carried out with the Goldmann contact lens and the Zeiss or Haag-Streit slit lamp immediately afterwards. This procedure was repeated at intervals during the day.

The illumination of the room in which gonioscopy was performed was arranged to be approximately the same as that in the room in which the patient had been waiting during the period of rising tension. This was a relatively simple matter, as the illumination was either the ordinary daylight existing at that particular time in the waiting room, or in some cases complete darkness into which the patient had been placed to induce a rise in tension. The contact glass was then inserted and the patient arranged comfortably at the slit lamp, which was then switched on for the angle to be examined in the usual way. The inferior part of the angle was almost invariably found to be open whatever the height of the tension, although it was extremely narrow in some cases.

When this preliminary examination had been made, the widest part of the angle was brought clearly into focus and the light was switched off. The patient was asked to keep still at this stage and as far as possible the whole system was held motionless for several seconds.

Then the light was switched on again. This was found to be awkward with the Zeiss instrument as the switch is not of the simple " on-off " variety but incorporates a rheostat, and the phenomenon about to be described was found to be more easily seen on the Haag-Streit instrument. With the sudden return of the light a definite change was seen to occur in the angle, not particularly impressive in some cases, but in others so marked as to justify the term dramatic. The change in its most extreme form can be described as the appearance of the rapid opening of a completely closed angle. In the less extreme cases the change consisted in a visible increase in the distance between the surface of the iris and the corneo-scleral trabeculae.

Case Reports

Only the cases in which an appreciable rise in tension occurred are included in the Table opposite.* It should, however, be mentioned that in the several eyes (not reported) in which no rise in tension occurred, closure of the angle was not found.

Comments

Where the filtration angle is already narrow it is difficult to detect changes in width unless one actually sees the change occurring. A few attempts were made to measure the angle-width with a graticule in the eyepiece of the slit-lamp, after the method of Gradle and Sugar (1940), but the technique was not found helpful in this type of case.

*In some cases included in the report, the tension was taken independently by Dr. A. DeRoetth, Jr., and the readings were not made known to the author until the completion of the day's work.

TABLE

Case No.	Age	Sex	Date	Eye	Miotic	Time	Tension (mm. Hg Schiötz)	Gonioscopy
1	74	F	Feb. 25, 1953	L	Pilocarpine 1 per cent.	10.00 a.m.	52	Angle very narrow, pigmented anterior trabeculae visible below No corneal oedema
						11.15 a.m.	31	View now obtainable right into cleft below, anterior trabeculae visible all round
2	54	M	Nov. 27, 1953	L	Eserine 1 per cent.	2.15 p.m.	48	Angle closed all round except chink below in which no details of wall can be seen No aqueous veins visible in episclera
						3.15 p.m.	45	
						3.30 p.m.	45	
						3.50 p.m.	28	Angle conspicuously more open. Chink all round, and some pigment spots seen below on posterior trabeculae not visible before Aqueous veins very prominent
3	47	F	Jan. 28, 1953	R	Eserine ¼ per cent.	2.05 p.m.	35	Angle not quite closed Small chink open at 5 and 12
						3.00 p.m.	25	Angle definitely more open
4	43	F	Jan. 26, 1953	R	Eserine ¼ per cent.	11.45 a.m.	45	Angle can be made to open and shut by turning light on and off
						12.00 noon		
						12.45 p.m.	25	Angle open all time and not made to shut by turning off light
5	56	M	Mar. 25, 1953	L		10.20 a.m.	45	Angle very narrow and appears shut except from 5 to 8. Narrow cleft and anterior trabeculae seen below. "On-and-off" shows iris coming close to Schwalbe at 7—not possible to be sure if touches
						11.30 a.m.	40	
						2.00 p.m.	31	Angle looks same but with more definite cleft all round. Opening and shutting sign++
						4.15 p.m.	35	
						4.35 p.m.	31	No clear change
6	63	F	May 20, 1953	R		10.00 a.m.	40	Narrow angle open 5 to 8, much black, finely divided trabecular pigment, chink just open 8 to 10, remainder closed. Opening and shutting sign nil.
			Tension by A. de Roetth			12.00 noon	38	No change
						2.00 p.m.	30	No change
						4.00 p.m.	30	No change
				L		10.00 a.m.	20	Narrow angle, appears closed from 10 to 2 only. Marked "on-off" sign but no obvious shutting

TABLE (*Contd.*)

Case No.	Age	Sex	Date	Eye	Miotic	Time	Tension (mm. Hg Schiötz)	Gonioscopy
7	69	M	May, 20 1953 Tension by A. de Roetth	R		10.30 a.m.	36	Angle open but narrow, very marked "on-off" sign
						12.15 a.m.	38	Same
						3.30 p.m.	33	Not gonioscoped
					Eserine	3.55 p.m.		
						4.15 p.m.	31	Not gonioscoped
				L		10.30 a.m.	46	Angle open but narrow, much bigger "on-off" excursion below than above
						12.15 a.m.	55	Anterior trabeculae visible below, very narrow chink above—not shut—no real change
						3.30 p.m.	63	No change
					Eserine	3.55 p.m.		
						4.15 p.m.	41	No doubt that angle is more open, pupil miotic
8	61	M	May 27, 1953	R		2.30 p.m.	22	Very narrow angle, anterior trabeculae visible below—few chinks show pigmented line along Schlemm's canal
				L		2.30 p.m.	39	Little more anterior trabeculae visible below than in R, but behind angle so narrow as to be virtually shut, pigment line at line of closure
						4.30 p.m.	50	No change
9	48	F	June 3, 1953 Tension by A. de Roetth	R		11.15 a.m.	20	Angle shut, P iridectomy not basal. Trephine well anterior? patent
				L		11.20 a.m.	46	Upper half of angle shut, lower half shows anterior trabeculae and chink into cleft at 5
						4.15 p.m.	30	Has had eserine—no change in angle
10	61	M	April 28, 1953 Tension by A. de Roetth	R	Eserine	4.00 p.m.	63	Very narrow angle, slightest chink visible below, iris face bowed and no convolutions
						4.15 p.m.		
						5.00 p.m.	22	Angle undoubtedly more open and whole width of trabeculae visible below. Elsewhere 60 per cent. of circumference showed peripheral anterior synechiae (P.A.S.), some extending across whole trabecular width, some partial
				L		4.00 p.m.	30	Angle very narrow, but at 4 base of iris is wavy and ciliary body can easily be seen for a short segment
11	63	F	June 5, 1953	R	Eserine ¼ per cent.	2.30 p.m.	48	Angle open in lower 10 per cent. only, apparently 90 per cent. P.A.S. elsewhere
						3.30 p.m.	25	Remarkable difference, angle now only medium-narrow and open all round, showing that above observation of P.A.S. incorrect, angle was merely closed by simple apposition of iris.

TABLE (*Contd.*)

Case No.	Age	Sex	Date	Eye	Miotic	Time	Tension (mm. Hg Schiötz)	Gonioscopy
12	69	M	July 14, 1953	R		3.00 p.m.	45	The angle appears completely closed and iris face much bowed
					Eserine			
						3.20 p.m.	25	Angle much more open, Schlemm's canal line now visible in lower half and anterior trabeculae above
13	59	F	Aug. 5, 1953	R		10.10 a.m.	28	Angle narrow but open, medium broad 6.30 to 8.30, marked variation "on-off"
						11.25 a.m.	31	Not gonioscoped
					Dark			
						12.15 p.m.	73	Angle closed except area 6.30 to 8.30—this area however definitely shuts with light off.
					Eserine			
						2.00 p.m.	25	Angle open all round, will not shut even in dark
				L		10.10 a.m.	63	Angle shut except 4.30 to 6.30, where medium-narrow, shuts on switching light off.
					Eserine ¼ per cent.	10.40 a.m.		
						11.25 a.m.	35	Angle narrow but open, all round except for P.A.S. at 6 and nasally. Some trabecular P.A.S. where angle widens at 4 to 5.30, may be more in depths of narrow parts, no "on-off" variation
					Dark	12.15 a.m.	43	Angle seems unchanged but definite variation in width on change of light amounting probably almost to closure at "off", pupil also reacts
					Eserine ¼ per cent.	12.30 a.m.		
						2.00 p.m.	25	Angle same but not made to vary or shut with light intensity

The only constant finding in this series was the fact that, viewed with the slit-lamp light switched on in the ordinary way, complete angle-closure was never seen with certainty.

Cases 1 and 2 showed an appearance suggestive of closure but I could not be certain about it. On the other hand, the instillation of eserine which was followed by a fall in tension did appear markedly to open the angle. (This action of eserine or pilocarpine was seen in all the cases in which it was used).

An interesting feature of the series was the occurrence of the sign previously mentioned of marked movement of the base of the iris on turning the light of the slit-lamp on and off. It would appear that this "on-off" sign has some value, for it can be used to show up angle-closure when ordinary continuous illumination suggests that the angle is open. In Case 4, for example, when the tension was 45 mm. Hg the angle could be made to open and shut by turning the light on and off. After eserine, however, and when the tension had subsided to 25, the "on-off" sign was no longer detectable and the angle appeared constantly to remain open.

Case 13, in which the excursion of the base of the iris was very obvious, also shows a close correlation between the presence of this sign and the level of the tension.

At the present stage no evidence is available as to the mechanism underlying the marked movement of the base of the iris with variations in light intensity. The obvious explanation would appear to be that the variation in the size of the pupil causes peripheral bunching during dilatation and thinning during miosis, but in the opinion of the author this does not explain the great variability from case to case. Some eyes in which pupillary movements are quite appreciable, give no very obvious movement of the base of the iris. On the other hand, Case 13 showed considerable movement of the base of the iris even when the pupillary reactions were considerably dampened down by eserine.

Conclusions

The evidence suggests that an opinion as to the openness of a narrow angle is of limited value unless the " on-off " technique is employed, since without this practically all the angles appear open because of the light of the slit lamp. Consequently, the significance of reports claiming the existence of open angles during periods of raised tension in cases of congestive glaucoma, is doubtful. It would be of interest if Weinstein's case, in which the tension rose to 80 mm. Hg on dark-room testing, could be re-gonioscoped by the " on-off " technique.

Summary

Theories relating to the mechanism of the rise in intra-ocular pressure in congestive glaucoma are discussed.

Thirteen cases thought to be of the congestive type of glaucoma were examined by tonometry and gonioscopy, and observations made in phases of both raised and normal tension. Elevation of tension was spontaneous in some cases (although congestion was not observed) and was induced in others by darkness. A return to normal tension was spontaneous in some eyes but had to be induced by miotics in others.

A new gonioscopic sign is described; marked variation in the width of the angle occurs in some eyes on turning the slit-lamp light on and off.

Complete closure of the angle in congestive glaucoma with raised tension, but in the non-congestive phase, is rarely seen if the eye is examined by the usual gonioscopic technique. The " on-off " technique gives an appearance which suggests that in some cases, the angle is in fact completely closed when the slit-lamp light is off (no studies of the angle in a fully established acute congestive attack are included in this series).

The excursion of the base of the iris elicited by the technique described is much more obvious in some eyes than others.

It is possible that previous reports of the presence of open angles with raised intra-ocular pressure in certain cases of congestive glaucoma should be treated with reserve, since the use of this new technique might have led to the conclusion that a given angle, which appeared by ordinary examination to be open, was in fact shut.

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DEGENERATIVE CHANGES IN THE RAT VISUAL PATHWAY WHEN THIAMIN AND RIBOFLAVIN DEFICIENCIES ARE COMBINED*

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IT was shown by the author in a recent paper (Rodger, 1953) that when thiamin deficiency in rats is of moderate degree and prolonged for about 6 months, degeneration of the visual pathway develops in certain of them. The dosages of thiamin used in the deficiency and control groups, which were not very clearly given in the earlier paper, are repeated in the present study, which deals with the effect on rats of combining thiamin and riboflavin deficiencies.

Choice of Diet.—In selecting what is described as the " Stock " diet in this and the previous paper, trials were performed with casein, salt, and the fat-soluble vitamins as constants, and the following variants:

(1) Glucose and the synthetic water-soluble vitamins,
(2) Glucose and autoclaved yeast,
(3) Dextrinized starch and the synthetic water-soluble vitamins,
(4) Dextrinized starch and autoclaved yeast.

The effectiveness of these diets in producing signs characteristic of thiamin deficiency after 6 weeks is shown in Table A, where it is seen that the diet which incorporated glucose and the synthetic water-soluble vitamins was the most successful in producing a deficiency. This also happened to be the one most easily prepared. The water-soluble vitamins and the two thiamin solutions mixed more readily with the glucose-casein base than with the starch-casein. It was suspected that some of the vitamin was lost in the latter mixture, but there appeared to be little likelihood of this happening with the fine dry glucose-casein powder which readily adsorbed moisture.

TABLE A

EFFECTIVENESS OF FOUR DIFFERENT THIAMIN DEFICIENCY DIETS

Diet (6 Rats)	Mean Heart Rate (beats/min.)	Mean Temp. (°F.)	Mean Wt. (g.)	Loss or Gain	Inco-ordination	Spasticity	Death
1	183·3	97^{2}	−22·6	0	5 severe	5	2
2	378·0	97^{4}	−13·6	1 gain	5 slight	0	0
3	366·6	98^{1}	−19·0	0	5 moderate	1	2
4	390·1	98^{3}	+ 2·4	3 losses	none	0	0

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Administration of Thiamin.—Thiamin (full) was the term used to describe the solution of thiamin hydrochloride given to the control rats in all our experiments, both in this series, and in the series described in the earlier paper. 1 ml. contained 500 μg. thiamin hydrochloride. This was the daily dose in the paired control animals; a huge one, it must be admitted.

Thiamin (minimal) was the term used to describe the solution of thiamin hydrochloride administered in the deficiency experiments. 1 ml. contained 10 μg. thiamin hydrochloride. The daily dose has varied, averaging about 0·5 ml. In the present experiments, an attempt was made to give the dose according to a preconceived plan. There is no doubt that this plan (Table B) was not so successful in producing a chronic thiamin deficiency as it might have been, for as it turned out the reduction in thiamin was too drastic. In the other chronic thiamin deficiency experiments, published in the earlier paper, but performed in point of time later than the present ones, better control was attained of the degree and duration of the deficiency by giving each individual rat personal attention, and by ringing the changes between 0·25, 0·5, and 1 ml. thiamin (minimal) according to its appetite. 0·25 ml. (about 2 μg.) was given daily first of all, and then at the first signs of anorexia, the dose was raised to 0·5 ml. Very rarely, 1 ml. was required to bring back the appetite; as soon as the rat resumed eating its entire daily feed, the dose was dropped again to 0·25 ml. In Experiments 3 and 4 described here, however, the plan was carried out.

TABLE B

ADMINISTRATION OF THIAMIN

Week	Thiamin Hydrochloride (μg.)
1	5 daily
2	none
3	5 daily
4	none
5	5 every other day
6	same
7	2 every other day
8	same
9	none
10	2 daily
11	none
12	start again

Administration of Riboflavin.—The daily dose of riboflavin was 0·3 mg. When excluded, for reasons that will be obvious later, it was excluded altogether.

Stock Diet.*—The diet of choice, designated as STOCK, was therefore as follows:

Casein	15	100
Salt Mixture	4	
Glucose	70	
WSV (synthetic water-soluble vitamins)	10	
FSV (synthetic fat-soluble E in cod liver-oil) ...	6–10 drops	

Histological Techniques

Fixation was performed within 10 minutes of death, immediately after the final heart-rate recording, and the last weighing. There is danger that autolysis simulating neuronal disease will occur in rat brains and eyeballs, especially the latter, when left unfixed for longer than this (Rodger, 1953). Nissl, Giemsa, triple, Marchi, Weigert-Pal, Loyez, silver nitrate, and polarized light were the techniques employed.

*Fuller details may be found in the earlier publication (Rodger, 1953).

Plan of Experiments

(1) Acute deficiency of thiamin due to administration of the analogue, combined with ariboflavinosis.

(2) Chronic deficiency of riboflavin.

(3) Chronic deficiency of thiamin on a high carbohydrate diet.

(4) Experiments 2 and 3 combined.

Results

(1) Acute Thiamin and Riboflavin Deficiency (Table I).

Duration.—19 days.

Diet.—Stock, less thiamin and riboflavin 15 g.
Pyrithiamin (Merck) 100 μg.

TABLE I
EXPERIMENT 1

Rat No.	Weight (g.)			Heart Rates (beats/min.)			Day killed
	Initial	Final	Difference	Initial	Final	Difference	
1	80	87	+ 7				19th
2	75	70	− 5	500	300	−200	19th
3	70	72	+ 2	480	250	−230	19th
4	80	77	− 3				19th
5	90	79	− 11	500	220	−280	19th
6	85	95	+ 10				19th

Clinical Behaviour.—On the 16th day all the rats became anorexic, leaving about a third of their daily ration. This is strongly suggestive in acute thiamin deficiency that the end is not far off. 3 days later, they ate nothing, spasticity of the hind legs was present in them all, even those which had gained a little weight, and Rats 3 and 4 fell over sideways on the inspection table, quite unable to stand (Fig. 1). The characteristic convulsive seizure occurred while picking up Rat 1. Spontaneous convulsions occurred in Rat 3 while the remaining rats were being weighed. Rat 6 was the strongest of the group,

Fig. 1.—Albino rat suffering from acute deficiency of thiamin and riboflavin in state of collapse 48 hrs before death. The attitude is characteristic.

but was killed with the others, as it was obviously moribund. No lesions of the corneae, skin, fur, or mucous membrane were found.

Pathological Observations.—No abnormalities of the visual pathway were found. Some of the twigs of the sciatic nerves which had been taken revealed degeneration of myelin with Marchi and with polarized light. Others were healthy. This observation agreed with those previously obtained in acute thiamin deficiency by itself (Rodger, 1953).

(2) CHRONIC RIBOFLAVIN DEFICIENCY (Table II and Fig. 12, p. 152).

Duration.—220 days.

Diet.—Stock, less riboflavin 15 g.
Thiamin (full) 500 μg.

Clinical Behaviour.—Here, with total absence of riboflavin from the diet, three of the group died by the 52nd day. By an unhappy coincidence, all three died in the early hours of the morning, and the pathological material had to be discarded, as the cadavers were discovered too late. This did not happen in any other experiment, and precautions were afterwards taken against such wastage. The three rats which so died, Nos. 3, 4, and 6, gained weight slowly during the first 3 weeks, but thereafter went downhill steadily, and became apathetic and bedraggled. At death, there was corneal neovascularization, hyperaemia of the nasal mucous membranes, and marked abdominal alopecia.

The other five rats continued to remain in moderately good health until the 160th day, when Nos. 1, 2, and 5 were killed (prematurely as is now seen to be the case). Rats 7 and 8, the most active of the group, lived happily although quietly for another 2 months, and were quite strong when killed then. It is presumed all the survivors of the initial phase were able to manufacture their own riboflavin, sufficient to keep them alive in moderate health, although as it will be seen all showed signs of chronic riboflavin deficiency. Swelling of the nasal and labial mucosa was marked, these mucous membranes being fiery red in addition. " Dandruff ", abdominal alopecia, and " spectacle ring " alopecia of the orbital regions were also marked. Neither corneal neovascularization nor cataract was seen.

Pathological Observations.—No abnormalities were found in the visual pathways of any of these rats.

TABLE II

EXPERIMENT 2

Rat No.	Weight (g.)			Heart Rates (beats/min.)			Day killed
	Initial	Final	Difference	Initial	Final	Difference	
1	85	130	+ 45	500	400	−100	160th
2	65	140	+ 75	550	420	−130	160th
3	75	75	−	500	—	—	52nd
4	80	70	− 10	500	—	—	45th
5	80	150	+ 70	500	420	− 80	160th
6	75	65	− 10	500	—	—	50th
7	72	180	+108	500	410	− 90	220th
8	85	183	+ 98	510	430	− 80	220th

(2A) PAIRED CONTROL TO ABOVE (Fig. 12, p. 152).

Diet.—Same plus 0·08 mg. riboflavin daily. Normal behaviour, appearance, and histology in all rats.

(3) CHRONIC THIAMIN DEFICIENCY, ASSOCIATED WITH HIGH CARBOHYDRATE DIET (Table III and Fig. 12, p. 152).

Duration.—85 days.

Diet.—Stock, less thiamin 15 g.
Thiamin (minimal) (See Table B).

Clinical Behaviour.—On the 35th day, the first signs of anorexia appeared in Rats 1 and 2. A fortnight later, wasting, lassitude, inco-ordination, and bedraggling were present in the entire group. On the 75th day, Rats 1 and 2 were found to be spastic when placed on the inspection table, while the others were almost so. As all the rats were going downhill rapidly and it was difficult to improve the appetites, the experiment was concluded within the next 10 days. Rats 3, 4, and 5 were the last to become spastic and be sacrificed. This was, as indicated in the introduction, a subacute rather than a chronic deficiency.

TABLE III
EXPERIMENT 3

Rat No.	Weight (g.)			Heart Rates (beats/min.)			Day killed
	Initial	Final	Difference	Initial	Final	Difference	
1	95	87	− 8	500	360	−140	75th
2	77	65	− 12	500	300	−200	78th
3	80	81	+ 1	500	360	−140	85th
4	82	72	− 10	500	420	− 80	85th
5	85	83	− 2	500	300	−200	85th
6	107	77	− 30	480	360	−120	75th

Pathological Observations.—Rats 1 and 5 exhibited signs of degeneration in the visual pathway of significant degree. The nerve fibres in nerve and tract were swollen and tortuous and varicose, although not grossly (Figs 2 and 3). Many long oligodendrocytic chains were present. The sheaths showed granular isotropism and swelling of the nodes with polarized light (Fig. 4), but Marchi bodies were only just significantly increased. This indicates of course that the lesion was in an early state. In the dorsal nucleus there were a few scattered sclerosed cells, all of which were hyperchromatic. The appearance of these cells suggested central chromatolysis, but as this was also present in the pair-fed animals, one concludes it is an artefact (Fig. 5). There was a slight degree of satellitosis. The retina was not affected.

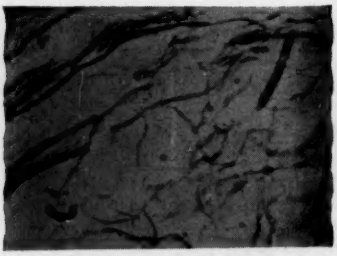

FIG. 2.—Normal visual fibres. Nerve fibres of optic tract seen spreading out through dorsal nucleus of lateral geniculate body. Author's silver, not counterstained. ×350.

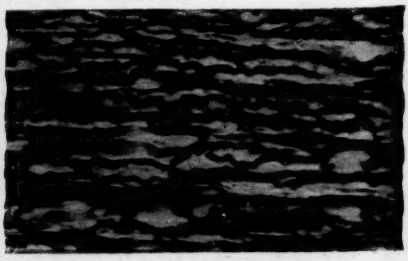

FIG. 3.—Tortuous nerve fibres in optic tract in subacute thiamin deficiency. Although the lesion is not gross, it is distinctive even at this stage. Author's silver. ×500.

FIG. 4.—Swelling of nodes of Ranvier and granular isotropism in optic nerve. A case of chronic thiamin deficiency. Diameter of optic fibres more than 2½ times less than that of sciatic fibres, and therefore very difficult to photograph. Polarized light. ×200

FIG. 5.—Hyperchromatic sclerosed visual cell body in chronic thiamin deficiency. Central chromatolysis of other cells considered to be artefact. Giemsa. ×700.

(3A) PAIRED CONTROL TO ABOVE (Fig. 12).

Diet.—Same plus thiamin (full). Normal behaviour and histology in all rats.

(4) CHRONIC THIAMIN AND RIBOFLAVIN DEFICIENCY (Table IV and Fig. 12).

Duration.—200 days.

Diet.—Stock, less thiamin and riboflavin 15 g.
Thiamin (minimal) (See Table B).

Clinical Behaviour.—The first four rats in this group were litter mates of those in Experiment 3, which became moribund after 75 days on a thiamin diet similar to the present one. In this group, surprisingly, the rats continued to live in moderately good health, and to grow, although at a reduced rate, long after their brothers of Experiment 3 had expired. The only difference between the two diets, it should be noted, is that in Experiment 4 no riboflavin is included.

All eight rats of this group ate well, and never appeared hungry, even when their weight had greatly increased. Their appetites were less voracious than those of the paired controls. After the 35th day they became noticeably listless, spending much time sleeping during the

TABLE IV

EXPERIMENT 4

Rat No.	Weight (g.)			Heart Rates (beats/min.)			Day killed
	Initial	Final	Difference	Initial	Final	Difference	
1	85	145	+ 60	500	360	−140	160th
2	75	100	+ 25	500	360	−140	130th
3	85	107	+ 22	500	320	−180	100th
4	80	142	+ 62	500	340	−160	160th
5	75	138	+ 63	500	380	−120	160th
6	85	150	+ 65	500	360	−140	160th
7	77	140	+ 63	500	365	−135	200th
8	75	145	+ 70	500	330	−170	200th

FIG. 6.—Spectacle-ring alopecia, dandruff, and swelling of nasal mucosa in chronic thiamin-riboflavin deficiency. (Rat is a hooded white).

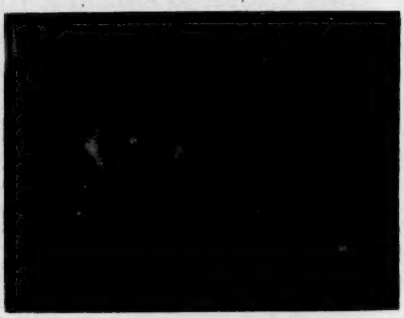

FIG. 7.—Same as Fig. 6, side view.

day. When roused, they proved quite active for short periods, running round the examination table like healthy rats, but they were never seen doing this in the cages. On the 56th day, alopecia was seen to commence around the eyes. Abdominal alopecia commenced insidiously. A closer search than usual on the 140th day revealed that all the rats had a degree of abdominal alopecia; well demarkated "spectacle-ring" alopecia, many small white scales on the fur (dandruff), and red swollen lips and nostrils (Figs 6 and7) were also noted. This was still the picture on the 160th day, by which day all the rats save Nos. 7 and 8 were killed. The appearance of the last two was unaltered when the experiment was completed 40 days later.

Pathological Observations.—Changes were seen in all the rats killed on or after the 160th day. These appear to be highly significant, except in the retinae. Vacuolation and cloudy swelling of the ganglion and bipolar cells of the retina we have been unable to exclude entirely from healthy retinal tissue. No other pathological change being seen, it was considered that no retinal lesion existed. The changes occurring in the rest of the visual pathway were as follows: thick clustered oligodendrocytic chains (a customary finding in all these deficiency experiments); swollen, varicose, and tortuous visual fibres, with some fragmentation centrally; myelin sheaths grossly destroyed in Rats 1, 4, and 8, and demyelinization present in all, diffuse, patchy, and with many plaques; the geniculate cells in all were hyperchromatic and sclerosed as a rule, but not invariably so, as had been the case in the previous experiments (Rodger, 1953). Satellitosis was present, and here and there neuronophagia could be seen (Figs 8, 9, 10, and 11, opposite).

The sciatic nerves revealed advanced demyelinization with Weigert-Pal, but as in Experiment 1, not in every twig, for some twigs were healthy throughout. Unlike Experiment 1, the peripherally placed nerve bundles only were affected.

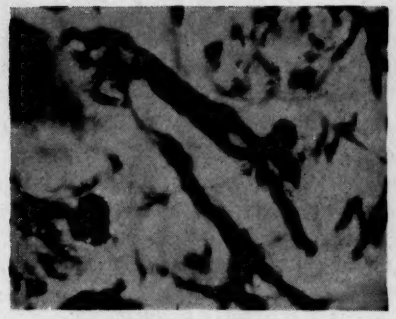

FIG. 8.—Swelling of terminations of optic tract fibres within dorsal nucleus in chronic thiamin-riboflavin deficiency. Note Held endings above synapsing on final neurone cell body. Author's silver. ×1,275.

FIG. 9.—Large plaque of demyelinization in intracranial portion of optic nerve in chronic thiamin-riboflavin deficiency. Weigert-Pal. ×650.

FIG. 10.—Old patchy demyelinization of optic tract in chronic thiamin-riboflavin deficiency. Loyez. ×200.

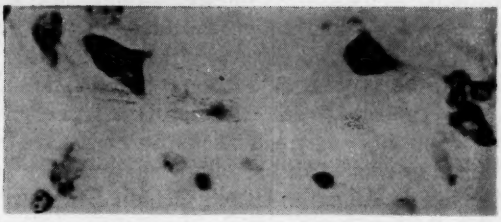

FIG. 11. — Hyperchromatic sclerosed cells in dorsal nucleus in chronic thiamin-riboflavin deficiency. Note also satellitosis and neuronophagia on right. Giemsa. ×400.

(4A) PAIRED CONTROL TO ABOVE (Fig. 12, overleaf).

Diet.—Same plus riboflavin and thiamin (full).

These rats developed normally, the heart rates dropping slightly, and only as they gained weight. The visual pathways exhibited none of the lesions found in the corresponding deficiency group.

Discussion

It is interesting to compare the pathologies of the chronic thiamin deficiency group (Rodger, 1953) with the combined thiamin-riboflavin deficiency group in the present study. These two experiments compare more favourably in point of time than does the so-called chronic thiamin deficiency described here with the combined. In the thiamin deficiency of longer duration (180 days), the lesions were much more marked than those found in the thiamin deficiency of 75–85 days (Experiment 3), as might be expected; thus

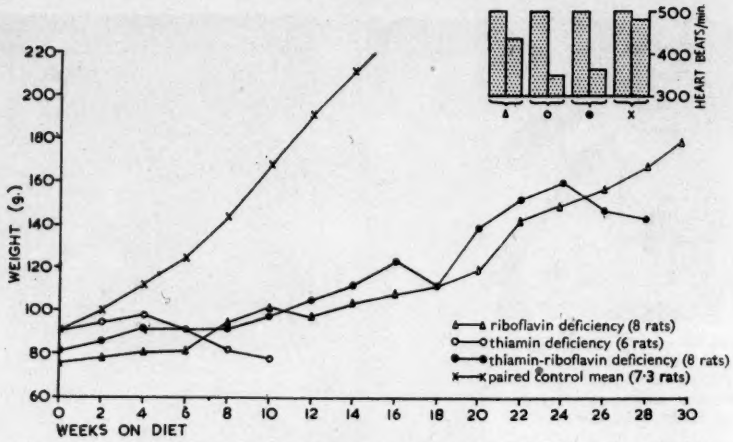

FIG. 12.—Average weight curves and heart rates (start and finish). Experiments 2, 3, and 4. with pair-fed control groups taken as one.

the latter is probably better designated as subacute. In prolonged thiamin deficiency, the fibres of the optic nerve and tract are distorted, swollen, varicose, and tortuous, the endings being enlarged, sometimes fragmented, and argyrophil ring-shapes much increased; long oligodendrocytic chains parallel with the myelin sheaths are present; the sheaths reveal diffusely scattered demyelinization, especially in the tract, and many grey and white plaques. The final visual neurones—the cell bodies and an occasional axis cylinder whose continuity with the cell body has not been severed—also take part in the process of degeneration; the cells are almost all sclerosed and deeply hyperchromatic, their processes swollen to nearly twice the natural size; neuronophagia and satellitosis completes this picture of a severe lesion. It is not possible to dissect out the optic radiations in the rat, but one presumes the changes found up to and including the start of the final visual neurone will be reflected throughout what little remains of the visual pathway. The lesions just described seem to be the obvious end-results of those found in the subacute group. How do they compare with the lesions found in the combined chronic deficiency of thiamin and riboflavin, the duration of each experiment being so nearly the same?

The nerve fibre distortions in nerve and tract are almost identical; the central terminations in the combined deficiency are not so grossly affected, but this is the only difference. The myelin changes are also almost similar, ballooning, irregularity of outline, diffusely scattered plaques, and many demyelinized patches being common to both groups. Although the lesions in the dorsal nucleus of the lateral geniculate body affecting the final visual neuron are not so gross in the combined deficiency, the changes which exist are in essence the same. In neither experiment were retinal changes significant.

Why these minor differences occur, if in fact they are differences, it is

impossible to say. It could be a highly significant observation, or no more than the sort of variation one is likely to find in short experimental series such as those described, even though more histological techniques than is usual were employed, with a corresponding increase, it is believed, in the accuracy of the observations.

Zimmerman (1943) states that in the dog twice the length of time is required to produce degeneration of the nervous system by riboflavin than by thiamin deficiency. On these premises we might conclude that Experiment 2 (220 days) did not last long enough. In short, it is dangerous to conclude from this one experiment that a riboflavin deficiency does not lead to degeneration of the visual neurons. Krukowska (1951) kept rats on a diet deficient in riboflavin for about 550 days. In the end they lost weight, and became almost bald. Unfortunately, he does not seem to have examined the visual pathway, and recorded changes in the anterior segment of the eyeball only: neovascularization, round-cell infiltration of the superficial and deep corneal layers, and cataract. These signs were first observed at the eighth week, so should have been present in the rats of Experiments 2 and 4. Some were observed, but not all. Cataract was absent from the list, although a degree of it might have been present, no ophthalmoscope being employed. There is sufficient in common, nevertheless, between Krukowska's and the present experiments to confirm the belief that in Experiments 3 and 4 a state of chronic ariboflavinosis had been attained.

The deficiency in thiamin, especially in the earlier study, forms an excellent " cross control " for the combined thiamin-riboflavin deficiency experiment. There can be no doubt that, in addition to chronic riboflavin deficiency, the rats of Experiment 4 were suffering from thiamin deficiency, the high degree of bradycardia being one indication of that (Fig. 12). It seems likely that, though these deficiencies were combined, it was the lack of thiamin which was responsible for the lesions described. Thiamin deficiency was the outstanding clinical feature in both groups; moreover, the pathological changes found in the combined deficiency group reflected almost exactly those found in the thiamin deficiency group, and no such changes existed in the riboflavine deficiency group. That the changes in each group were significant is proved by their total absence in the pair-fed rats of the control groups.

The histology of the skin and mucous membranes was not studied, but it should be mentioned that no macroscopic lesions referable to these tissues were observed other than the scaly dermatitis (described above as "dandruff") and the swelling of the naso-labial mucosa. These changes were certainly due to the riboflavin deficiency. Pyridoxine was administered at the comparatively high level of 0·08 mg. daily. Many workers give only 0.01 mg. without lesions developing. Sinclair (1952) from his own experiments, drew attention to the cutaneous lesions found in pyridoxine and fat deficiency, a fact which was unknown to the writer when these experiments were started

in 1950. Nevertheless, the supply of essential fatty acids, as well as of pyridoxine, would appear to have been ample. In a total of nearly 200 thiamin deficient rats examined during the last few years, true acanthosis and hyperkeratosis was never observed, although slight degrees of it might have been missed in the early stages.

If these experiments, visual data apart, do nothing else, they lend support to the belief held by many biochemists that when thiamin deficiency is combined with that of riboflavin or of any other respiratory-enzyme vitamin, the requirement for thiamin is greatly reduced. This seems to have been the case in Experiment 4, in which all the rats outlasted the rats of Experiment 3, although the degree of thiamin deficiency was the same in each. The rats of Experiment 4 lived more than twice as long as the others, in a better state of health, and might still be alive, if they had not been killed. This may be because in the combined deficiency the metabolism was made to depend more upon fat. Interaction and interdependence between the different members of the vitamin B complex is believed to occur; they are probably all capable of forming different enzyme systems with different proteins according to circumstances.

Though there must be fallacies in any argument based on conclusions reached by animal experimentation, the results here obtained seem to support the theory that when the B vitamins are deficient and the diet is high in carbohydrates (a state of affairs mercifully extremely rare, even in time of famine) it is the lack of thiamin which is directly responsible for the amblyopia. This is still partly conjectural, as so many factors are involved, but there is a parallel in the observation by Zimmerman (1943) that thiamin often evokes a response in the early treatment of pellagra, where niacin fails, although both may have been deficient.

These arguments suggest that it might be wiser as a routine procedure when treating nutritional amblyopia to give thiamin and a well-adjusted diet not too rich in the other vitamins or in protein, rather than a " blunderbuss " therapy incorporating every known and imagined vitamin preparation. Treatment of the latter kind did not prevent a further loss of sight (from partly-blind to fully-blind) in almost one-third of 238 cases of nutritional amblyopia resulting from the last war (Rodger, 1952). After the high promise of better things which these patients rightly expected, the loss of what little vision remained to them must have been a bitter blow.

The sciatic nerve changes about which there is so much controversy are recorded without comment for the benefit of those interested.

Summary

(1) Three groups of rats were fed a high carbohydrate diet. In one group, thiamin was administered at an inadequate level; in a second, riboflavin was withheld; and in the third, the diet was made deficient in both these vitamins to the same degree.

(2) The thiamin deficient rats died at the end of 75–85 days; some of the riboflavin deficient rats which were apparently able to manufacture a little of the vitamin symbiotically were still alive at the end of 220 days; and the thiamin-riboflavin deficient lived up to 200 days, when the experiment was terminated.

(3) Slight signs of degeneration were found in the visual pathways of the thiamin deficient; none in the riboflavin deficient; and gross changes in the thiamin-riboflavin deficient. Control rats on isocaloric diets with full vitamin supplements were not affected.

(4) A fourth series of rats made acutely deficient in thiamin (by administration of the analogue) and in riboflavin showed no signs of degeneration in the visual pathways.

(5) It is concluded that prolonged thiamin deficiency with a predominantly carbohydrate diet leads to optic atrophy; when riboflavin is deficient in addition, the animal lives longer—for reasons not yet fully understood—and the thiamin deficiency is even more prolonged, so that the lesions involving the visual pathways become grosser still.

(6) The findings are briefly referred to human nutritional amblyopia.

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FURTHER EXPERIENCES OF INTRA-OCULAR ACRYLIC LENS SURGERY*

WITH A REPORT OF MORE THAN 100 CASES

BY

HAROLD RIDLEY

London

THE intra-ocular acrylic lens operation has now been practised for 3½ years, but it was not until March 1, 1951, that a satisfactory lens was employed. Since then over 150 operations have been performed (Table 1). The experience gained from a considerable series of cases under the care of one surgeon may now be of value, for though the lens design and general technique have not been changed many lessons have been learned.

TABLE I

SCHEDULE OF 140 CASES

Series No.	Date	No. of Cases	Remarks
1*	1949–50	4	These extracapsular cases are omitted as lenses were of abnormal specification
2*	1950–51	21 extracapsular 2 intracapsular	
3	1952–53	70 extracapsular 16 intracapsular	5 extracapsular cases operated on in U.S.A. and Canada omitted.
4	1953	29 extracapsular	Results not yet assessed.

B.J.O.* (1952), **36, 121.

Toleration of the Intra-Ocular Acrylic Lens

The first and most important observation is that the artificial lens of standard design composed of Transpex and correctly inserted in an eye is well tolerated for several years. We do not, of course, yet know whether any degenerative changes will be found to occur either in the patient's eye or in the acrylic lens in 10 years or in 50 years, but at the present time there is nothing to suggest future trouble. On the contrary, the longer the lens has been in place the better it appears to be tolerated, the clearer is its surface, and the whiter the eye. This is of overwhelming importance, for had the contrary been found it might have been necessary to discard the operation or at least modify the lens or the surgical technique.

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Surgical Technique

This has undergone little change since the operation was first described. The pre-operative pupil size is important and not always easy to adjust. No drops other than cocaine and adrenaline are now used, and about $\frac{2}{3}$ dilatation (6 mm.) is desirable. Without homatropine considerable tone is left in the iris and the effect of miotics, when necessary, is rapid. If the aperture is too large it is difficult to place the lens edge beneath the lower part of the iris, and delay may be caused during the operation while miotics constrict the pupil, for clearly the section cannot be closed and the operation concluded until the lens is securely in place behind the iris. Frequently, during extraction of the cataract or irrigation of the anterior chamber, the pupil will constrict, but the acrylic lens can be made to slide through a pupil as small as 3 mm.

Efficient removal of the anterior capsule before expression of the lens is also important, but may prove far from easy. Probably the best technique is to incise the capsule with a cystitome around the lower half of the pupil, and then to grasp the central area with capsule forceps, tearing away as large a piece as possible. Sometimes it may be necessary to insert the forceps more than once. After expression of the nucleus, thorough irrigation of the anterior chamber with sterile normal saline is essential for adequate removal of soft lens matter. This can be surprisingly effective, and it has been found possible to obtain satisfactory results with very immature cataracts, even with those confined to the posterior cortex in which intracapsular technique would formerly have been employed. It is remarkable that throughout the series it has never yet been found necessary to postpone insertion of the acrylic lens until a second operation. Two-stage surgery has, however, been performed where a lens has previously been removed by perfect extracapsular surgery or as a result of trauma, and it would certainly be advisable if soft matter remained in the eye.

If after irrigation some anterior capsular remnants are seen in the upper part of the eye, they are best removed by seizing them with smooth bladed capsule forceps and cutting with de Wecker's scissors, not tearing them away for fear of removing the posterior capsule as well, so rendering the operation an " inadvertent intracapsular ". If capsule tags remain in the lower part of the eye, it may not be possible to reach them for treatment in this way, but the lens can be slid beneath them and the remnants left to shrink up. A final irrigation after the corneo-scleral sutures are tied helps to centralize the lens and permits the pupil to move freely over it from the beginning.

Vitreous loss has occurred in only three of 140 cases in which an intra-ocular acrylic lens has been used. In one, an early deliberate intracapsular, the lens broke the vitreous face and had to be removed immediately. In one, a traumatic cataract, vitreous prolapsed through a hole in the centre of the posterior capsule; the lens was inserted and, though the eye looks satisfactory, acuity is only 6/60, which suggests further intra-ocular traumatic disturbance. In one case a small bead of vitreous came through the peripheral iridectomy, but the case has done well. It must be admitted that in a few more cases vitreous has been lost during the extraction but as the acrylic lens has not been employed in these operations the accident cannot be attributed to the lens. In some at least of these it is highly probable that pre-operative subluxation of the lens was present, for with monocular cataracts of obscure aetiology this and other complications must inevitably be encountered occasionally.

Lens Design

The lens design appears to have been fortunate and no change has been made. The precise position within the eye clearly affects the final refraction, but usually the eye is rendered about 1 D myopic compared with its fellow, which, with a fixed focus, is preferable to emmetropia should the unoperated eye be normal. The present diameter of 8·35 mm. appears satisfactory as regards ease of insertion, adequate retention in place, and absence of pressure on the ciliary region and filtration angle.

Intracapsular Cases

The combination of intracapsular extraction and insertion of an acrylic lens proved unsatisfactory. Deliberate intracapsular technique was employed in ten cases in which the cataract, though causing gross visual disturbance, was largely confined to the nucleus or the posterior cortex. It proved possible to slide the acrylic lens over the unbroken vitreous face and to set it in position behind a central and circular pupil, a procedure which clearly requires exceptional care and must carry far more than average risk.

In eight other cases, described as " inadvertent intracapsulars ", extracapsular extraction had been planned but the posterior capsule was removed accidentally. Sometimes, after extraction of the lens, tags of anterior capsule are seen and, if these are seized with forceps and pulled out, the thin posterior capsule or a large portion of it is apt to be removed too.

Ten eyes underwent deliberate intracapsular extraction. In all these the intraocular acrylic lens was inserted perfectly, but in no less than seven it underwent spontaneous and generally gradual dislocation into the base of the vitreous chamber. This misfortune occurred not immediately, but several months after operation, in some instances in association with attacks of coughing. Since only three cases remain satisfactory, the incidence of late dislocation is prohibitive, and the intracapsular technique must be regarded as contraindicated.

Eight eyes are known to have had " inadvertent intracapsular extraction ", and there may be others in which damage to the posterior capsule has occurred unobserved. In three of these cases dislocation resulted, in one only 8 days after operation just when the patient was due to return home.

It is interesting however to note that, unlike a dislocated natural lens, the acrylic lens sets up little if any reaction in the eye, especially if the vitreous face is unbroken; this observation has been confirmed by other surgeons. The patients, however, though they may have good acuity with an aphakic spectacle correction, are bitterly disappointed by the change, and this emphasizes the optical advantages of the intraocular acrylic lens.

It is evident that without an intact posterior lens capsule the risk of late dislocation of the intra-ocular acrylic lens is inacceptable. This finding was not unexpected, but it is unfortunate, because intracapsular surgery is followed by very slight reaction and the eye may have an active pupil and good sight as early as the first post-operative dressing.

TABLE II

VISUAL RESULTS (INTRACAPSULAR)

Visual Acuity	6/6 to 6/5	6/9	6/12	6/18	6/24	6/36	6/60	Below 6/60	Lens Dislocated	Patient Dead or Untraced
Deliberate 10	1	1	1	—	—	—	—	—	7	—
Inadvertent 8	3	1	1	—	—	—	—	—	3	—

Most of the eyes with dislocated acrylic lenses can see well with an aphakic spectacle lens.

Extracapsular Cases

Insertion of an intra-ocular acrylic lens after extracapsular extraction is the only method now employed, and with good surgery can produce excellent results.

Where the posterior lens capsule has not been damaged there has been no dislocation of the lens in the absence of trauma. Three cases however had injuries. A boy was struck in the eye by a fist and one half of the lens, which was never quite satisfactorily placed, slipped in front of the iris; reposition was unsatisfactory and the lens had to be removed. A man was struck on the eye by a tennis ball; the displacement was similar but was satisfactorily treated by passing an iris repositor through a small corneal incision. The only other case was that of a woman who fell to the ground and was rendered unconscious for 10 to 15 minutes; her face and brow were cut and the acrylic lens dislocated into the vitreous through a tear in the posterior capsule.

TABLE III

VISUAL RESULTS (EXTRACAPSULAR)

Visual Acuity	6/6 to 6/5	6/9	6/12	6/18	6/24	6/36	6/60	Below 6/60	Lens Dislocated	Patient Dead or Untraced
Series 2 21	7	5	0	2	1	1		1	1	3
Series 3 70	21	20	7 1 amblyopic	9	2 1 amblyopic	2	2 2 amblyopic	5	1	1
Total Percent.	34	32	8	12	3	4	—	7	—	—

Among extracapsular cases, at least four poor visual results were due to amblyopia or lesions of the retina. In the two traumatic dislocations the former acuity was 6/9.

The refraction of the acrylic lens eye resembles that of the other eye in the great majority of cases. (In one, both eyes require −6·0 D.cyl., axis 90°). The average post-operative astigmatism is 1·75 D.

Among extracapsular cases, nearly two-thirds can see 6/9 or more (without the magnification provided by a cataract glass) and half of these can see 6/6 or 6/5.

Improvement in acuity is expected in many cases which are at present below standard. Only five eyes, other than those which are amblyopic or contain dislocated lenses, seem beyond reasonable hope of 6/9.

Posterior Capsule

It was foreseen at the start by many surgeons that the posterior capsule might thicken, and that "secondary cataract" might cause visual deterioration some time after operation. It was hoped, however, that the pressure of the lens on this very thin membrane would prevent wrinkling and thickening and this, in fact, has been our experience so far. Case 2 underwent capsulotomy from behind; this proves

that this operation can be performed, but in no other patient has it been considered necessary. It is probable that in some cases visual acuity is somewhat reduced by opacities in this membrane, though in many visual acuity of 6/6 or 6/5 has been attained in spite of the presence of an intact posterior capsule.

Complications

Post-operative Iritis.—Some degree of post-operative iritis is to be expected, though it is slight in intracapsular and two-stage extracapsular operations. This most troublesome common complication is attributable to operative trauma, and perhaps to the leaving of a little cortex adherent to capsular tags. Care must be taken to wash the lens adequately after sterilization and to perform the operation neatly and gently, avoiding any unnecessary manipulation. After operation the pupil should be maintained with atropine at a diameter of about 4·5 mm. Cortisone ointment is valuable in controlling inflammation but should not be used before the fifth day for fear of delaying the healing of the corneo-scleral section. Though individual variation is inevitable, fair vision may be expected in one month and good visual acuity in 3 months.

Occlusion of the Pupil.—In some cases, especially if the pupil has been allowed to constrict, a dense inflammatory membrane may occlude the pupil. When the iritis is no longer active this may be effectively divided by manipulation of a Ziegler's knife passed through the limbus, care being taken to avoid damaging the lens. Mydricaine and cortisone are injected subconjunctivally. The results are often dramatic, 6/12 usually being attained within one week with a good prospect of higher visual acuity later.

Glaucoma.—A slight temporary rise of tension has been encountered in a few cases, but has readily responded to miotics; a drainage operation has been required in one case in which the cataract surgery was very defective. Secondary glaucoma due to iris bombé caused by dense synechiae around the pupil was met with twice but responded to iridotomy. There have also been two cases of a somewhat similar type of secondary glaucoma associated with loss of the anterior chamber. This complication due to seclusion of the pupil by broad adhesions between the surface of the lens and the back of the iris had been treated by performing one or more small peripheral iridotomies.

Post-operative Diplopia.—This has occurred in a few cases in association with prolonged disuse of the cataractous eye. So far it has never failed to disappear spontaneously without muscle surgery or suppression of one image, even though in one case there was pre-operative divergence of 10°.

Constitutional Disease.—Diabetes, and other forms of severe constitutional disorder, such as gross hypertension, cardiac failure, and severe respiratory disease, are regarded as a contraindication to any surgery except that which is essential and simple. Nevertheless intra-ocular acrylic lenses have been inserted in the eyes of three fully controlled diabetics. In two of these more than average iritis resulted but the other was quite uncomplicated and provided a visual acuity of 6/6. Care is required in the selection of cases, and where more than average risk is present this should be explained to the patient.

Heterochromic Cyclitis.—This frequent cause of uniocular cataract is not a contra-indication to the use of an intra-ocular acrylic lens. No more than average post-operative reaction is usual in these cases.

Removal of Acrylic Lens

In only one case, following traumatic subluxation, has an acrylic lens been removed. It was readily grasped by the peripheral grooves. So far we have not removed any eye containing an acrylic lens.

Discussion

The verdict of 3½ years experience is that the intra-ocular acrylic lens operation has a definite place in ophthalmic surgery.

For the uniocular cataract it is unrivalled and may well prove to be the ultimate treatment, for binocular vision is restored. Unlike a contact glass, the intra-ocular acrylic lens causes no unnatural magnification which may prevent binocular vision, nor any sensation of a foreign body; it requires no maintenance or adjustment by the patient and does not give rise to temporary veiling. There are relatively few cataract patients who have the dexterity to insert a contact glass or the perseverance to become accustomed to the discomfort, however accurate the fit.

In senile cataract the advantages are less obvious, for plain extraction gives the patient the two essentials, the ability to go about alone and to read. Often, however, aphakic patients enabled to see 6/6 in the centre of the field complain that "the sight is not natural". Many refuse to wear a cataract glass if the other eye retains fair sight.

In assessing the results, it is not right to judge solely by the central acuity of the single eye; the total visual function of the patient is the true criterion. The intra-ocular acrylic lens restores throughout the full visual field natural sight which may be quite equal to that of a normal presbyopic eye in which accommodation is lost. Furthermore, with an intra-ocular acrylic lens in one eye, both eyes can be used together until the second cataract matures. Many patients prefer binocular vision with acuity even as low as 6/12 and 6/12 to an incompatible pair of eyes, one seeing 6/12 and the other capable of 6/6 with an aphakic correction which they dislike. Among the most grateful and satisfied patients are those who have 6/18 unaided with one eye, and the ability to read newsprint without a glass with the eye with an acrylic lens.

Time has yet to show whether in cases of bilateral cataract the evident optical, cosmetic, and psychological advantages outweigh the disadvantages of extra complication and slower recovery of sight compared with the classical technique; but there is evidence, in the scores of good results and the general absence of severe complications, that in years to come, though not at present, the acrylic lens may be the operation of choice for all cataracts which are uncomplicated by severe ocular or constitutional disease. There is no indication so far that the lenticulus greatly increases the risk of late complications or that it will not last a lifetime;

it seems that after full convalescence, though this may sometimes be prolonged, further trouble need not be anticipated. Several patients now have successful intra-ocular acrylic lenses in both eyes.

Perhaps no other operation in ophthalmic surgery more accurately reflects the degree of skill and care of good surgery. The surgeon and his patient are playing for higher stakes. Success will be rewarded by restoration of almost natural vision very different from that provided by cataract glasses. On the other hand, any unnecessary manipulation or surgical faults which might pass with plain extraction are liable to be heavily penalized. The new surgery is not yet advisable for every cataract patient and is as yet only to be recommended to thoroughly experienced surgeons, but reports from many parts of the world are evidence that results can be obtained which are unequalled by any other form of cataract treatment. Now at last nearly normal and natural sight can be restored, sometimes without any external optical aid.

Summary

The lessons learnt from over one hundred intra-ocular acrylic lens operations are described, and a Table of visual results is appended.

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FAMILIAL ECTOPIA LENTIS AND ITS COMPLICATIONS*

BY

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FAMILIAL ectopia lentis is a well recognized condition and is usually seen by the ophthalmologist in its fully developed stage. It was thought worth while to record this family, as some of the very earliest stages have been observed and the complications of the condition have been very varied. The family is a large one, spread over a large part of the Union of South Africa, and it has not been possible to see as many of its members as one would wish. Much of the evidence presented in the family tree was given by one of the older members of the family, herself a sufferer from the condition, who seemed to have made it her business to find out about the vision of her relatives. Some of the patients described below consulted my father over a period of many years, and it is only more recently that I have had the opportunity of seeing them myself and of watching the onset and the course of the condition in one of the younger members. Several of the patients only sought advice in the later stages of the condition, by which time there was little or no sight to be retrieved.

Features of the Condition

Most of the complications of this condition which have been described are presented by one or other member of this family, so that a resumé of the main features of the condition will include those found in these cases. Marfan's syndrome, first described in 1896 without ocular changes, comprises the physical features of elongated long bones (especially those of the hands and feet) and spinal curvatures; it is of interest that the members of this family are all tall, many being over 6 ft. in height, but that arachnodactyly is not present.

A good many of the patients in this family had auburn or red hair, and were of the opinion that this colouring was associated with the ocular abnormalities. I have not been able to substantiate this supposition; as far as I can tell, the colour of hair gives no easy guide to their ocular troubles.

Early Descriptions.—Congenital subluxation of the lens has a strong hereditary background, being usually transmitted as a dominant characteristic. It was described by von Graefe (1854), and Morton (1879) gave examples transmitted through five generations. The literature suggests that it is almost four times more frequent amongst males than amongst females, but this finding is not confirmed by the

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present series. The condition occurs in this family during the fourth and fifth decades of life, with a tendency to anticipation in the younger generations.

Cause.—This appears to be a degeneration of the zonular fibres. Once the zonule has weakened, dislocation becomes easier by the mere weight of the lens or by minor traumata. The zonular fibres degenerate at the edge of the lens, so that the free margin of the lens can often be seen. Associated with the zonular degeneration, the vitreous also tends to liquefy, and herniation of vitreous may occur through the zonular defect into the anterior chamber.

Progress.—This is well demonstrated by the case of III, 10, who was an Air Force pilot and as such presumably had excellent unaided vision in each eye. He was also a first-class rifle shot, who regularly took part in competitive range shooting, and when first seen his only complaint was difficulty in seeing targets on the shooting range. He had been examined for flying two months earlier, and had been told then that the vision in one eye had deteriorated to 6/9 from its previous 6/6. When seen by me his vision had deteriorated further to 6/36 and 6/24, but with a correction for myopia and astigmatism it was restored to 6/6. At this time he showed iridodonesis of both irides, not throughout their whole extent but localized to two-thirds of the circumference of the limbus. During the next few months the iridodonesis became total. The relaxation of the suspensory mechanism of the lens resulted in a lenticular myopia as the lens assumed a more spherical shape. His astigmatism became more marked, and one assumes that this was due to tilting of the lens and to unequal traction of the zonule in its different parts as the zonular fibres were degenerating. The lens is described as being most commonly displaced sideways in these conditions, but this displacement is as yet small in his case.

The usual deep anterior chamber was well demonstrated in his case at this stage. Such subluxated lenses may then produce effects other than those due to the changes of refraction. The lens may leave part of the pupil aphakic, and produce a most annoying set of images, as in one case in this series. The subluxated lenses may become opaque, and, although this is stated to be relatively rare, cataract has been a common occurrence in the family. More usually a secondary glaucoma follows, or an irritative iridocyclitis is set up. The reason for the occurrence of such a glaucoma has been a matter for speculation as such cases are usually seen with deep anterior chambers. In the case of III, 10, the previously deep anterior chambers have become extremely shallow, and iridodonesis is no longer easily evident. One feels that he must now be approaching a stage at which glaucoma will become manifest; the refraction has become progressively more myopic the ocular tension is normal, the fields are full, and the discs are not cupped.

For further changes one must look at other members of the family. Complete dislocation of the lens may occur, and when this takes place into the anterior chamber it may produce glaucoma, either when the lens is impacted in the pupil or when it enters completely into the anterior chamber (Heath, 1941). This complication is best treated by mydriatics and posture in an attempt to get the lens back through the pupil, and if necessary by subsequent extraction. Such a case is IV, 12, whose second eye seems perfectly normal so far. Posterior dislocation, not seen in this family, has been described in the literature, and the cataractous lens may lie in the vitreous sometimes for years without any other ill-effects.

Ocular Tension.—The literature suggests that a rise in tension is not very commonly associated with subluxation of the lens, and if one accepts this view, then the

relatively large number of cases of glaucoma in this family may be due to a more total dislocation of the lens than is usually present, the resultant acute glaucoma being responsible for the poor visual results. The best treatment for such cases, if the lens does not return through the pupil after using mydriatics, is intracapsular lens extraction after the tension has been reduced to as normal a level as possible.

Material

The first evidence of the condition in this family was found in I, 2, mother of II, 2, 3, and 4, the three oldest cases examined in the series; she was not seen by us, but her eldest daughter (II, 2) reported that she had always been short-sighted and had been told in 1917 that she had dislocated lenses and glaucoma. She had emigrated from Europe to S. Africa many years ago, so that it is unlikely that the affliction can be traced further back.

I, 2 had altogether two sons and four daughters, all with poor sight. The elder son (II, 1) had cataracts, and one of his three sons had poor sight, though the reason for this is not available. The next three children (II, 2, 3, and 4) had dislocated lenses, cataracts, and glaucoma. The two youngest daughters (II, 5 and 6), both of whom died in their forties, had poor eyesight for which operations were undertaken.

The youngest of the four daughters (II, 6) had two children whose eyesight, as far as is known, is satisfactory.

The next youngest daughter (II, 5) had five children (III, 22–26) only one of whom (III,

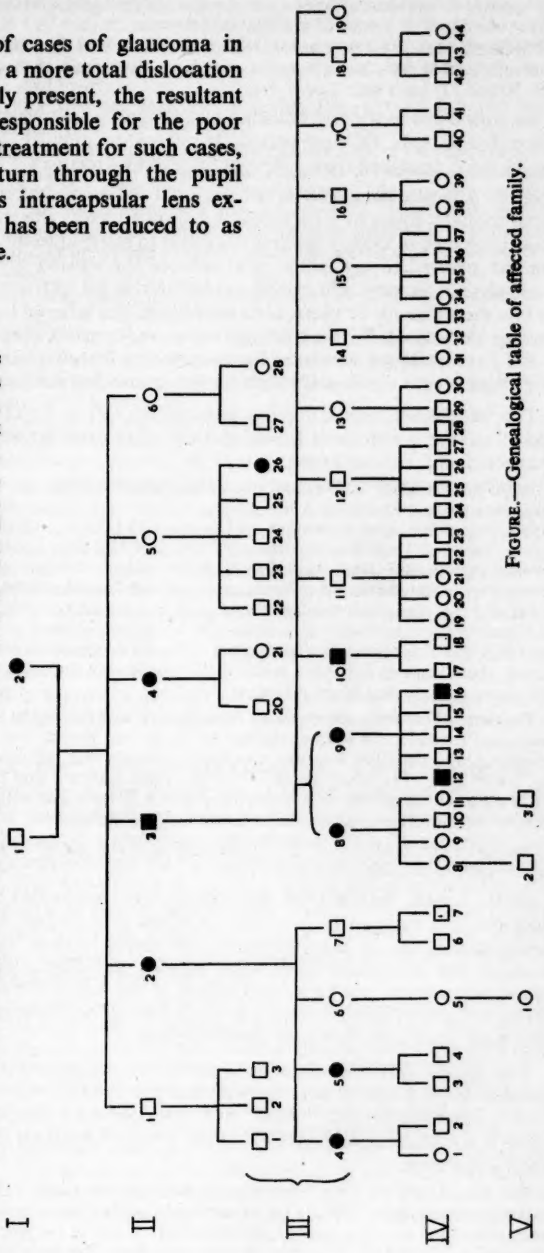

FIGURE.—Genealogical table of affected family.

26) appears to have had affected eyes; she was highly myopic with lenses dislocated up and in, and at the age of 31 years had a retinal detachment.

The third youngest daughter (II, 4) was known to have had glaucoma, dislocated lenses, and cataracts, and to have had successful operations performed on her eyes. She had two children (III, 20 and 21) both with " poor eyes ".

We now come to the two branches of the family about which we know most; that of II, 2 and that of II, 3. Of those previously referred to, only III, 26 was seen by us, the others having been described from information given by relatives.

(1) II, 2, female born in 1878, had her right eye enucleated in 1932 for an absolute glaucoma brought about by a cataractous dislocated lens. Shortly afterwards, she developed acute glaucoma in the left eye and this failed to respond to the miotics used. At this stage she was referred to my father, who reduced the tension by a trephine operation with a complete iridectomy, after which her vision was 6/9 with a correction. She was not seen by him thereafter for 10 years, until in 1942 she was referred back to him, and he extracted the lens intracapsularly; the corrected vision was then 6/6, the field full, and the disc normal. In the 10 years during which she has since been followed up, the disc has remained normal, and vision a year ago was 6/9 with some commencing senile macular changes.

This patient has three daughters and one son (III, 4–7); of these, two daughters (III, 4 and III, 5) show dislocated lenses, and the other daughter and son (III, 6 and III, 7) are unaffected so far as we know.

The eldest daughter (III, 4) has always been short-sighted, and since the age of 44 has shown some lens striae. Her myopia has increased from −1·5 D.sph.−0·75 D.cyl., and −2 D.sph.−0·5 D. cyl., when first seen in 1946, to −4 D.sph.−2·75 D. cyl., and −3 D.sph.−2 D. cyl., when last seen in January, 1953. Her accommodative power has been poor; she required a +1·75 D.sph. for near sight in 1946, and to-day she requires an added +3 D.sph. to enable her to read J 1. There is as yet no iridodonesis, but at her most recent visit the internal edges of the lenses could be seen, indicating that the lenses had dislocated slightly temporally. The interest in her case lies in the fact that there have been lens striae for some years now, in the ever increasing myopia, especially the astigmatic error, and extremely poor accommodation. In retrospect, knowing the family, these features indicate a laxity of the zonule, and the edges of the lenses can now be seen, indicating that the lenses are displaced.

The other affected daughter (III, 5), born in 1911, was told at the age of 7 years that she had " undeveloped lenses ". In 1923 at the age of 13 she had already had the left lens needled on three occasions, and the right lens was dislocated upwards and inwards. She was not seen again by my father until 1943 when he extracted the right cataract, and the remnants of the left lens. Since then her vision has been correctable to 6/9 in each eye. In November, 1952, the maculae showed degenerative changes, but discs were still quite normal.

The seven grandchildren (IV, 1–7), ranging up to the age of 30 years, and one great-grandchild (V, 1), aged 9, all have satisfactory sight.

(2) II, 3, male, born in 1880, was told in 1914 that he had dislocated lenses. The same diagnosis was made in 1921, and in 1925 and 1926 he had operations to his eyes for the cataracts that had by then developed. He seems to have had a series of post-operative mishaps and his history gives some idea of the difficulties his surgeons encountered. When first seen by my father and myself at the end of 1951, he was aphakic, the visual acuity being 6/36 with correction in the right eye, and counting fingers at 1 m. in the left eye: both discs were pale and deeply cupped.

This patient has a family of six sons and six daughters (III 8–19), of whom two twin daughters (III, 8 and 9) born in 1903, and one son (III, 10) have been seen by us. Of the others, one daughter (III, ?) has " one very poor eye ", but, as she has not been seen, the cause is not known; two sons (III, ? and ?) have " impaired vision ", the reason being also not known to us.

The two sisters III, 8 and 9 appear to be uniovular twins. III, 8 apparently had no ocular trouble until in April, 1950, when she noticed that her vision was becoming blurred, and glasses were prescribed but soon seemed unsatisfactory. Later in the year she developed pain in the right eye, and in November, 1950, this eye was trephined. The same night the left eye became painful

and a month later a complete iridectomy was performed on the left eye. She was first seen by me in 1951, by which time vision was reduced to perception of light, bilateral dislocated lenses with cataracts were present, and the tension was raised. Cyclodialyses were done to improve the tension and the cataracts were extracted. The visual result was not a great improvement but the eyes have remained quiet and the tension satisfactory.

Of her four children (IV 8–11) one has weak eyes requiring glasses, but I have no further definite information about them.

III 9, the second twin, first had an attack of glaucoma with loss of sight of the right eye in 1948. The left eye gave no trouble until July, 1951, an attack of glaucoma developed, and she had an operation (?trephine). She was first seen by me in September, 1951, when neither eye had an anterior chamber and both lenses were cataractous and dislocated. A cyclodialysis, and later extraction, was done on the left eye, and vision improved slightly from perception of light to hand movements at 2 ft. A corneal dystrophy, one of the complications of this type of condition, has subsequently also become worse.

Of her five sons (IV, 12–16), three have no ocular complaints; one of the three aged 28, has been examined, and shows no signs of dislocated lenses.

The youngest son (IV, 16), born in 1927, has had a " lazy " left eye as long as he can remember and has worn glasses since he was 10 years old. Both anterior chambers are deep.

The right iris shows an area of iridodonesis in the lower nasal quadrant, and vision is correctable to 6/5 with −0·75 D.sph. −1·5 D. cyl. at 90°.

The left eye is 10° divergent, and the iris shows iridodonesis over its whole surface. The lower edge of the lens is visible at times in the lower part of the pupil, the field is full and the discs normal, and vision can be corrected to 6/18 with −12 D.sph. −3 D.cyl. at 45°.

The eldest son (IV, 12), born in 1922, had good sight until the end of 1948 when the vision of the left eye became blurred.

In October, 1951, he was told that he had a dislocated lens, and vision in the left eye was reduced to 5/60, whereas on his discharge from the Army in 1945 he had been able to read 6/6.

The right eye appeared to be normal but required −2 D.cyl. to read 6/6. The left eye showed a shallow anterior chamber, with the lens dislocated downwards and inwards, and vision correctable to 6/9 with −7 D.sph. −1 D. cyl. At times he had pain of a glaucomatous nature in the left eye and this had not improved with the use of miotics. The refraction had changed further so that in May, 1953, vision in the right eye was 6/9 with −3·5 D. cyl., and in the left 6/12 with −14 D.sph. −3 D.cyl.

Of the 37 grandchildren (IV 8–44) two (V, 12 and 16) are so far known to have had dislocated lenses, and a third has suspect eyes. A full investigation of all these grandchildren might well produce many more cases.

I think the case of III, 10, born in 1916, the third child of II, 3 to be afflicted with the condition, is the most instructive, as the earliest stages of the condition can be traced. He was a distinguished pilot in the Air Force, with a sound career both non-operational and operational behind him, and a first-class rifle shot (having taken many prizes at the ranges), and these features bear out his claim that when he was examined routinely for flying in 1950 the vision in each eye was 6/6. In 1951 he was told that the vision of the right eye had deteriorated a little to 6/9 but nobody took much notice of this at the time. In September, 1951, he began to notice difficulty in seeing the target at the shooting range; this first brought him in touch with ophthalmologists, and his sight became so poor that he was eventually discharged from the forces.

In December, 1951, he had deep anterior chambers with iridodonesis of two-thirds of both irides. There was a suggestion of transverse folds in the posterior capsule of the left lens. Unaided vision was 6/36 in the right eye and 6/24 in the left, and could be corrected to 6/5 with −1·5 D.sph. −0·5 D. cyl. at 180° for the right eye, and −1·25 D.sph. −1 D.cyl. at 180° for the left eye. A month later he required an extra −1 D.sph. for each eye to restore his vision to 6/5, and in another month his correction to attain 6/6 was −3 D.sph. −1·5 D.cyl. at 85° for the right eye, and −4·5 D. sph. −0·5 D. cyl. at 20° for the left eye. Six months later his correction had further altered to −6 D. sph. −1·75 D. cyl. at 70° right and −6 D. sph. −1·5 D. cyl. at 85° left. Thus during the 8 months in which he was under observation, his myopia had increased by more than four dioptres, and the axis of his cylinder had changed from horizontal to more or less vertical. During this time he also required a reading correction and used one of his weaker pairs of glasses for this purpose.

When he was seen next in the middle of November, 1952, a change in the physical findings had occurred. His refraction had not changed much in the right eye, but the left eye now required −6·5 D.sph. −2 D. cyl. at 95° to attain 6/9 vision. The striking feature now was that whereas the anterior chambers had previously been deep, they were now very shallow, and his pupils were larger than one had become accustomed to in his case. There was now no iridodonesis present, and the discs and tension were normal. In March, 1953, there was but little change, and his blind spots were of a normal size.

The problem now to be faced in his case is whether he has reached the stage at which glaucoma attacks are to be expected, and if so what is the best line of treatment to be adopted. Had he been seen for the first time in November, 1952, it would have been extremely difficult to diagnose the presence of subluxated lenses clinically. His twin sisters (II, 8–9) reached the glaucoma stage before they sought advice and the results of operative treatment were extremely disappointing. His aunt (II, 2), was successfully relieved of symptoms by a trephine and only had the lens extracted about 10 years later.

Discussion

Relationship with Marfan's Syndrome.—In the literature, one finds extensive accounts of ectopia lentis associated with arachnodactyly and other lesions and abnormalities usually referred to as Marfan's syndrome. This syndrome was exhaustively reviewed by Rados (1942), who summarized the cases reported up to that time, and later by Ross (1949), who collected a further 117 cases. Between them these authors collected the findings in 321 cases. The present series does not fit into the classification of Marfan's syndrome, nor into the type known as Marchesani's syndrome, about which little appears in the literature, where the distinguishing features are the presence of brachycephalic skulls (instead of the usual dolichocephalic skulls found in cases of Marfan's syndrome), short fat limbs, and spherophakia.

The findings can be grouped into defects of three systems:

(1) *Skeletal Defects.*—These comprise dolichocephalic skulls with prominent supra-orbital ridges, frontal bossing, and broad sunken noses. The palatal arch is narrow and the chin prominent and massive. The face is thin with a wrinkled skin and the patients look prematurely aged and have a melancholy or pained expression. The ears are often malformed. The limbs are long and slender, the span between the fingertips of the outstretched arms being greater than the height of the individual. The bones of the hands and feet are elongated and there may be webbing of the fingers. The chest may be funnel shaped or flattened, and kyphosis and scoliosis are common. The scapulae are often winged, and the joints, especially the elbows, fingers, and knees, are lax and subluxation may occur. About 75 per cent. of the cases in Rados's and Ross's series had skeletal changes, 40 per cent. high arched palates, and 20 per cent. abnormal ears.

(2) *General and Visceral Defects.*—The muscles are poorly developed and there is an absence of subcutaneous fat which makes these patients look taller than they really are. The cardiovascular lesions seem to be the most serious in the lives of the patients, but not much stress is laid on these in the ophthalmological text-books. The incidence in Marfan's syndrome is about 20 per cent., but there tends to be a paucity of symptoms referable to cardiovascular lesions. In the heart, patent foramen ovale, and inter-auricular and interventricular defects are the commonest lesions; fenestration of the aortic valves, coarctation of the aorta, cardiac failure, and patent ductus arteriosus also occur (Lambie, Shellshear, and Shellshear, 1950). The aorta often shows hypoplasia with aneurysm formation and aortic incompetence, and fatal rupture of the aorta has occurred. Of a group of 23 cases of arachnodactyly that have come to autopsy, thirteen had valvular lesions, eleven aortic disease with aneurysm formation (and rupture of the aneurysm in 4 cases), and eight had congenital lesions of the inter-atrial septum (Reynolds, 1950; Fishl and Ruthberg, 1951). The cardiovascular lesions are caused by a deficiency in the elastic tissue

of the media of the blood vessels, but whether this is due to a mesoblastic developmental defect, or only arises later in life as the result of intrinsic defects in the vasa vasorum of the larger vessels, is not known. The aorta may show cystic and mucinous degeneration of the media, and a resulting aneurysm represents the most serious complication of this disease, often proving fatal in early adult life. The degenerative disposition may not be confined to the aorta, but may extend to the larger arteries of the extremities (Lindeboom and Westerveld-Brandon, 1950). Marvel and Genovese (1951) report aortic aneurysms found in fifteen of 28 cases at autopsy, eight being dissecting aneurysms.

In addition, these patients seem to have a cardiovascular system especially prone to the ravages of rheumatic fever.

Besides the cardiovascular lesions, abnormal configurations of the lungs have been found, with variations in the segmental lobular development. Vestigial lobes are found in the lungs; the right lung may show only two lobes, or the left lung only one (Hamwi, 1951); and these cases are said to be predisposed to respiratory infections. It is, then, these cardiovascular and respiratory lesions which are the danger to life in cases of Marfan's syndrome.

(3) *Ocular Defects.*—Classically the lenses are dislocated, usually symmetrically upwards and outwards, though other forms do occur. In addition, spherophakia and lenticular myopia may occur, with axial myopia and myopic degeneration at the posterior pole of the globe occurring less commonly. Hypermetropia has been recorded, but seems to be infrequent. Associated with the ectopia of the lenses, is iridodonesis, which may be partial or extend over the whole of the iris. The pupils are usually small and are said to dilate poorly with mydriatics, because of the poor development of the dilator pupillae muscle. The dislocation is usually incomplete, but may develop into a complete dislocation with resultant glaucoma if the lens comes forward into the anterior chamber. Lens opacities and notchings of the lens margin are often found, and elongation of the zonular fibres or deficiency of the zonule may be present. Strabismus (either convergent or divergent) has been reported in Marfan's syndrome, as also quite a high incidence of corectopia and persistent pupillary membrane. Colobomata of the iris, choroid, and disc have also been reported, though these malformations are rare.

Presence of Arachnodactyly.—The difficulty in the cases presented here is that the patients do not seem to show arachnodactyly. We do know however that Marfan's syndrome can be present without the skeletal defects, or without the ocular or cardio-vascular defects—the so-called "forme fruste" types (Reynolds, 1950). In fact, it has been suggested that aortic aneurysms for which no other cause could be found should be regarded as a type of Marfan's syndrome, and that the relatives of cases should be examined to exclude the condition. The determining factor producing these types has been suggested to be a disturbance in the time of the orderly sequence of developmental events during the first few months of intrauterine life (Lambie, Shellshear, and Shellshear, 1950). One may also consider these forms as the result of a single dominant autosomal factor, the effects of which are sensitive to modification by other inherited genetic modifiers and perhaps to factors in the early environment (Lutman and Neel, 1949). If we do accept these cases as presenting a variety of Marfan's syndrome, we are confronted with the problem of the age of onset of the symptoms. The ocular signs and symptoms of Marfan's syndrome are usually well established at a much younger age than they occur in this family, and do not seem to have a progressive nature such as those described here. Ectopia lentis may be traumatic in origin, but that aetiological factor would hardly account for the dislocated lenses in this family unless one postulates minor traumata on a previously weakened zonular structure, *i.e.*, a congenital background. Ectopia lentis may be secondary to some ocular disease

or degeneration—hardly a likely cause in several members of a family. So we are left with an aetiology based on development.

Clarke (1939) subdivides congenital dislocation of the lens as follows:

(1) *Simple.*—There is a defective zonule and ciliary body, and apart from the dislocation of the lens, the eye is grossly normal.

(2) *Associated with anomalies of ocular dimension, e.g.*, ectopia with axial myopia, microphthalmos, or buphthalmos.

(3) *Associated with anomalies of ocular structure, e.g.*, persistent pupillary membrane, corectopia, aniridia, polycoria, coloboma of iris, choroid, or lens, and megalocornea.

(4) *Associated with congenital anomalies elsewhere in the body, e.g.*, dwarfism or arachnodactyly.

The family here described would seem to belong to Clarke's Group 1, and the findings of glaucoma, cataract, and detachment are then considered to be the complications and not the cause of the ectopia. In this classification, however, the condition is referred to as congenital with defects in the suspensory mechanism of the lens. In other series of cases described, the ocular defects first became manifest at a much younger age than in this family. Ectopia has been reported in cases of Marfan's syndrome at the age of 18 months, and is often referred to as being first noticed when the child goes to school. In this family going to school does not seem to have brought to light any ocular weaknesses.

Lloyd (1948) subdivides cases of ectopia lentis into two groups:

(1) Non-progressive cases,

(2) Cases that later develop poor vision, progressive displacement of the lenses, choroidal atrophy, and vitreous opacities.

This second group he classes as an abiotrophy which can already be recognized at the age of 10 years. Possibly then, in our cases the lesions could be classed as abiotrophies rather than as congenital defects. The possibility of the postnatal development of true arachnodactyly in a previously normal person has not been solved, but the probability of such an occurrence is extremely remote. We know of other abiotrophies occurring in the eye, and I see no reason why this should not be responsible for the development of ectopia lentis in what was previously apparently a normal eye.

Falls and Cotterman (1943) examined a family of some 119 members, of whom 25 had ectopia lentis, and none showed sufficient deformities to permit of a diagnosis of arachnodactyly. The condition was inherited as a dominant gene, so that about 50 per cent. of the offspring of an affected parent were affected. Some of the cases showed parents who had no obvious abnormal ocular signs, and it was postulated that in these normal parents there had been a lack of penetrance of the gene responsible for the ectopia lentis. This family showed no corectopia and the pupils dilated well with mydriatics. Glaucoma was a frequent occurrence, resulting from either luxation of the lens into the anterior chamber, or of a type more akin to the usual primary non-congestive type. They also found that the dislocated lenses were predisposed to cataract formation. They recommend early refraction to avoid the occurrence of amblyopia and squint, and routine miotics to counteract the tendency for dislocation of the lens into the anterior chamber.

Needling of these lenses gave poor results, and in the cases of non-acute glaucoma cyclodialysis seemed to be the best of the decompression operations.

Harshman (1948) reports a family to which the conditions found in our cases approximate closely. Three generations were affected and, of the ten members who had glaucoma, six had dislocated lenses and a seventh an incipient cataract. These patients first noted the onset of symptoms during the fourth to sixth decade of life, and these began with the development of myopia or a relatively sudden increase in the degree of myopia. After these refractive changes, glaucoma developed with an acute onset. This type of glaucoma differs greatly from the usual hereditary glaucoma of the non-congestive, insidious, and chronic type. Harshman achieved the best results by performing a basal iridectomy followed by extraction of the lens.

Clarke (1939), however, points out the danger of vitreous loss, which occurred in five out of ten cases subjected to preliminary iridectomy, and in seven of ten extractions done after a preliminary iridectomy. Seven of his ten cases showed visual improvement after operation. Clarke advised that 2 months should elapse between operations, and recommended that the cataract be removed by a scoop extraction. The ultimate prognosis of the untreated cases was poor.

Therapy.—There seems to be little doubt that the glaucoma in the family reported above results from subluxated lenses, and the answer would appear to be to extract the lenses, once symptoms have become apparent. Watching the progress of III, 10, one wonders what signs and symptoms should make one advise operation. Until November, 1952, I had thought that one could wait until the symptoms of glaucoma made themselves evident, and I expected the anterior chambers to become still deeper. Now I wonder whether extremely shallow anterior chambers do not evolve before the glaucoma symptoms supervene, and whether an emergency operation might not then give such good results. I doubt whether I should be bold enough to extract the lens in such an emergency unless it were completely in the anterior chamber. One is loth to extract a clear but subluxated lens, through which a corrected visual acuity of 6/6 or 6/9 can still be obtained, on the chance of averting glaucomatous attacks. I had anticipated that the nutrition of the lens might be impaired by its altered position and physical conditions, so that cataractous changes were produced, before glaucoma supervened. Then, as vision deteriorated as the result of cataract, one would feel better justified in extracting the lens, achieving thereby the dual result of removing the opacifying lens and also the potential cause of glaucoma.

There is no reason why conservative treatment of a glaucomatous attack should not be successful; it has been so in the case of IV, 12, though we must remember that the lens may become impacted in the pupil, producing a " glaucoma inversum ". If conservative treatment is satisfactory, should one later advocate surgical intervention? Probably it would be better to do so. The operation of choice appears to be a cyclodialysis, as a trephine may so easily become blocked by the vitreous which is often present in the anterior chamber in cases of dislocated lens, and was in fact noted in III, 10. The cyclodialysis is not a very traumatizing operation; it can be repeated if

need be in another quadrant of the eye, and is of no embarrassment if extraction of the lens later becomes necessary. On the whole therefore, one should perhaps assume that a decompression operation should be undertaken prophylactically when the anterior chamber shows definite signs of becoming shallower, unless glaucoma symptoms have previously occurred. Then, as the lens becomes opaque, extraction will have to be undertaken. The technique employed for this depends on individual preference, the strong possibility of vitreous being present in the anterior chamber, and the tendency for loss of vitreous in extracting a dislocated lens being higher than with an ordinary cataractous lens being borne in mind.

What of the other members of the family in whom no suspicious signs have yet been seen? I do not think one can give any assurance that the condition will not occur as they get older. It is hard to say at what age the first signs most often appear—the fourth and fifth decades of life seem to be most common, although some cases have started earlier. The only advice one can give is to have their eyes examined at intervals, so that if any sudden increase in myopia should occur they may be seen at 2- or 3-monthly intervals until the diagnosis of subluxated lens can be confirmed or rejected.

Summary

A family is described in which ectopia lentis with complications affecting twelve persons has been traced through four generations. Various other members of the family have doubtfully healthy eyes and more cases may develop as the years pass. The development of the condition is followed in one patient, and the supervision of such cases is discussed.

I should like to acknowledge the help I have received in the preparation of this paper from my father, Dr. R. C. J. Meyer, who first drew my attention to this interesting family. I am also grateful to Dr. H. J. Hamelberg, who allowed me to see IV, 12, one of the cases described above.

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EXPERIENCE WITH THE HARRINGTON ERISOPHAKE IN FIFTY CATARACT EXTRACTIONS*

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In 1951, Dr. David Harrington of the Division of Ophthalmology, University of California, San Francisco, sent me one of his erisophakes. Since then I have used the instrument sporadically, by which I mean that in an operating list of two, three, or four cataract extractions, an occasional one was done with the erisophake, the rest in the ordinary way. Fifty such extractions have now been performed and a note of my experience may be of some interest to others who may contemplate using this instrument.

The phakoerisis of Barraquer Barraquer and Barraquer Moner in Barcelona is very impressive to watch, and the results obtained at their hands seem excellent, but the space-and-time-machine-like meter on one of the operating theatre walls which has to be watched and consulted, and on which the amount of suction seems to depend, is rather awe-inspiring.

The Harrington erisophake is a modification of that of Bell (1948), which in its turn is a simplification of the sucking-disc type of instrument evolved by Dimitry (1939). It has the advantage over the instruments of Hulen (1911) and Barraquer (1922) in that it is simple in construction and requires no central suction-producing apparatus. As Dimitry himself stated:

> the only vacuum required to provoke a grasp in a sucking disc is that measured in the bore of the needle and the concavity of the cup.

Dimitry's sucking disc, however, was found to be cumbersome in use and required unaccustomed positions of the hand. Bell's simplification consisted in fastening a small rubber contact glass sucking bulb to a Dimitry tip, and when this was squeezed between the thumb and the forefinger it produced enough suction to attach the sucking cup strongly to the anterior lens capsule.

Harrington felt, perhaps correctly, that with only the support of the rubber bulb the needle was apt to wobble when introduced into the anterior chamber, and his modification involved incorporating the bulb into an elongated metal case, rigidly fastened to the needle holding the suction cup. The instrument, as it stands, consists of a metal tube 13 cm. long and rather less in diameter than an ordinary lead pencil. At the lower end two windows opposite to each other permit pressure to be applied by the thumb and forefinger to a rubber suction bulb contained in the case; the bulb is attached to the handle, at the tip of which is the suction cup.

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The effect is essentially that of a cross-action-forceps, in that once the instrument has been applied to the lens capsule no further pressure is needed. The rigidity of the container allows complete control of both the vacuum cup and the lens attached to it. The whole is easily assembled and disassembled and can be sterilized in the ordinary way by boiling after filling the bulb with water, or by immersion for 15 minutes in borax and formaldehyde solution (B.P.) followed by 2 minutes in the boiler. Before using the instrument after sterilization, it is better to make certain that all fluid is expressed out of it by rigid pressure on the rubber with thumb and forefinger.

In recent years other modifications of Bell's original erisophake have been made (e.g. Esposito, 1952), but an examination of the literature shows that the principle remains unchanged. A similar instrument described by Veirs (1952) has four small round apertures in the cup instead of a single-opening tip and this is designed to prevent rupture of the capsule.

Dynamics of Phakoerisis.—Harrington (1951), by studies of animal and cadaver eyes and by highly magnified moving pictures of erisophake extractions on the living human eye, with microscopic and photographic studies of the extracted lenses, endeavoured to show that the dynamic principle in phakoerisis is wholly dissimilar from the mechanics of zonular rupture, lens dislocation, and intracapsular lens extraction by the method of combined external pressure and forceps traction. It is believed that the modern sucking disc exerts a powerful and evenly-distributed pull on the anterior lens capsule, and through it on the zonular lamella which is actually drawn forward on to the anterior lens surface and forms the " button " of anterior capsule to be described later.

Operative Experience

In this series the cases were entirely unselected, being a cross section of those normally encountered in the out-patient department. The eldest was about 87 and the youngest 44 years of age. The series included nuclear sclerosis, generalized cortical hardening, and one or two cases of hypermature lenticular degeneration. Three cases of " secondary " cataract, following upon iritis and with total synechiae, are included and will be dealt with later.

After the removal of the lens there appears to be no difference in the postoperative behaviour between cases operated with the erisophake, and those dealt with by the usual method of lens removal. No unusual features of any kind were noticed. The early ones have now been watched for over 2 years and have gone on as any successful cataract extraction may do.

Corneal Section.—In the majority of cases the corneal section was made with the Graefe knife cutting a conjunctival flap. A few of the later ones have had a preprepared flap and a section with keratome and scissors. In each case one or two conjunctival stitches were laid. As is my normal practice, a full iridectomy was done in the case of elderly patients to obviate if possible a second visit to the theatre

for iris prolapse. In the younger patients, a round pupil with, or without, a peripheral iridectomy or iridotomy was attempted. Care was taken in each case to ensure that the corneal section was at least a hemi-section—this is very important —and if necessary it was enlarged to this extent with scissors. In all cases where it was assessed by previous slit-lamp examination that the lens was both large and hard, a full iridectomy was done before the extraction irrespective of age.

Technique.—To apply the erisophake, the instrument is held like a pencil and gripped with the thumb and forefinger of the operating hand. Pressure is applied by both on the suction tube through the windows in the metal case. The instrument is slowly inserted into the anterior chamber, and the pressure is maintained while the suction disc is carefully placed in the centre of the anterior capsule of the lens. A very little downward pressure is then exerted on the suction cup, and the thumb and forefinger are slowly released to take a fresh grip on the metal case on each side of the windows but near enough to the openings to break the suction immediately should that be called for. This manoeuvre of releasing the pressure of the two fingers on the rubber tube, after its insertion into the anterior chamber, immediately initiates the required suction. It takes a second or two to accomplish this and this time is utilized by the suction in drawing the capsule into the vacuum cup. The operator feels at once that there is a union between the instrument, his hand, and the lens.

In the first case tried, the suction was easily obtained, but the combined bulk of the suction disc and a fairly thick lens made one feel that the entire mass could not be got safely out of the wound without risk to the vitreous; largely on account of inexperience and perhaps timidity, therefore, the suction was broken by pressing on the rubber tube and the instrument was removed, the lens being extracted with Arruga's forceps in the ordinary way. It was found that the suction had produced a nice little " button " of capsule in the centre of the anterior surface of the lens which made for easy grasping with the intracapsular forceps. This discovery has subsequently been made use of in a number of cases, chiefly for intumescent lenses on which the intracapsular forceps slip and take no grip; the method is to apply the erisophake to the anterior lens capsule for a second or two and then, having removed it, to grasp with the forceps the little raised " button " of capsule. With a little experience, however, the combined thickness of the disc and the lens, produced no terrors, and it was found that lenses could be removed with surprising ease.

In early cases the instrument was inserted vertically in the 12 o'clock position, but it was found a little difficult to exercise the rotation called for in order to rupture the zonule. Later it was found better (and this I believe is the technique Harrington uses) to insert the instrument at either end of the corneal section—that is roughly speaking in either the 10 or the 2 o'clock position—and then, when the suction has been obtained, gently to bring the handle, together with the suction cup and the lens, slowly into the 12 o'clock position. This manoeuvre, with a few rocking movements, is usually sufficient to free the lens. I formed the opinion that in some cases the suction alone seemed adequate to rupture the zonule.

It has been recommended to apply the instrument to the lower pole of the lens when " tumbling " is required and to the upper pole when the sliding straight withdrawal technique is desired, but in this series it was found much better to apply the suction cup fairly and squarely to the centre of the lens in each case,

because it could not be foretold which part of the zonule would rupture first, and the central grip seemed the most advantageous. In a personal communication from Harrington on this matter I am informed that he now also adopts this procedure.

In the early stages it not infrequently happened that the suction broke before the lens was removed. The instrument, however, could easily be replaced and a fresh suction hold taken. This occurs less frequently now, and I think it was due to excessive concentration on what was being done, accompanied by inadvertent pressure on the rubber tube, which broke the hold of the sucking disc on the capsule. Sometimes the suction has broken when the lens was almost ready to come through the wound, perhaps because the lens was unusually large or the section inadequate. In several such cases, the erisophake has been replaced, and the lenses steadied by a squint hook outside the cornea and safely removed. In others, the erisophake has been discarded and the lens gently expelled by pressure from outside the cornea with the Sinclair lens guard, assisted by the tip of the cystitome when the lens appears at the lips of the wound. Great care has to be exercised in using the cystitome in this way in case the point catches in the iris.

In cases where the suction hold had broken, even several times, there did not appear to be any risk of either iris or vitreous becoming drawn into the cup, as has occurred in the machine operated types, because once the hold on the lens capsule is broken it would require the usual manual pressure through the metal windows once more to produce further suction.

One case is of particular interest in that rapid and easy suction appeared to be obtained on the lens capsule and the lens appeared to be freed, but when an attempt was made to begin the extraction of the lens it appeared that the vitreous was coming with it as if there was some attachment between the two in the form of a capsulo-hyaloid ligament in the patellar fossa, or a post-inflammatory adhesion. The suction was broken immediately, the erisophake removed, the anterior face of the capsule torn away with the capsulectomy forceps and the lens expressed.

With reference to " tumbling " the writer does not feel satisfied that the true " bascule " of the forceps method, so ably demonstrated in the Edinburgh School over a quarter of a century ago, takes place with the erisophake. What has happened, however, in four cases, is that the lens has "tumbled" inside the capsule ending up in a crosswise position antero-posteriorly in the anterior chamber. This has been difficult to deal with. Some of the lenses have been pushed out, others have been lifted out with the cystitome or by any other method which the exigency of the moment seemed to call for. It would seem that these lenses were too hard to be moulded through the pupil as an immature nuclear sclerosed cataract can be moulded. Undoubtedly, as is the case with the intracapsular forceps, the most successful cases are just those cases of immature nuclear sclerosis. Other hard lenses without this intracapsular rotation have been safely removed without any " tumbling ". It is difficult to see how a hard lens, which has a suction cup placed squarely on its surface, can possibly " tumble " in the accepted sense.

In cases of complicated post-iritic cataract, the usual procedure of passing a repositor through a peripheral iridectomy to break down the adhesions was followed, and the lens was removed by suction without any difficulty, but, as has happened not infrequently to the writer in this type of case, no matter how the lens was extracted, the tags which were removed from the lens capsule but re-

mained attached to the iris, appeared to adhere together in the centre of the pupil. These are very difficult to deal with and end in a very indifferent visual result. It is now thought better in such cases to do a wide and full iridectomy.

Conclusions

The opinion is formed that this is a simple and safe method of doing intracapsular extractions, provided it is remembered that the delivery of the lens takes, perhaps, a little longer with the erisophake than with the forceps. This is not a plea for its use to replace a well-performed extracapsular operation which leaves an intact posterior capsule and hyaloid membrane between the vitreous and the anterior chamber. If, however, such an extracapsular extraction requires a needling then I think the position is as before. The complications encountered are listed in Table I.

TABLE I

COMPLICATIONS

Complications	Number of Cases		Percentage
Lens rotated inside capsule	4		8
Capsule ruptured (one intentional and described)	2		4
Erisophake applied more than once, otherwise straightforward	12		24
	Intracapsularly	Extracapsularly	
Cases finished by forceps	5	2	16
	Large Saccular Hernia in Anterior Chamber	Bulging of Hyaloid in Pupil	
Post-operative vitreous hernia into anterior chamber*	nil	11	16

*Only 35 of the 50 cases were examined, all within 3 to 4 weeks of operation.

Rupture of the Capsule.—This occasionally occurs in everybody's hands with the forceps, but did not occur in those cases which were removed straightaway with the initial suction. In two of the cases where the lens shifted within the capsule and lay crosswise in the anterior chamber, an attempt was made to remove it by suction, and the capsule ruptured, appearing so to do posteriorly. The cataract and the capsule were easily removed.

Vitreous Loss.—This was not encountered in any case, but one patient, a woman with relatively high myopia, showed fluid vitreous in the anterior chamber the moment it was attempted to place the suction disc on to the anterior lens capsule. That technique was abandoned and the lens removed in the ordinary way. It is felt that this contretemps was not due to the erisophake, as it has occurred both in intracapsular and extracapsular extractions by the more usual methods.

Herniation of the Vitreous.—A point of considerable interest to the writer and one not so far encountered in the literature, is the question whether erisophake extractions, with and without iridectomy, are less prone to hernia of the vitreous into the anterior chamber, which so frequently occurs after forceps intracapsular extractions either soon afterwards or as a late manifestation, and which after a time causes deterioration of visual acuity by rupture.

Table II has been taken from an excellent paper by Irvine (1953), in which, however, erisophake extractions are not specially mentioned.

TABLE II

FREQUENCY OF OCCURRENCE OF COMPONENTS OF SYNDROME (after Irving, 1953)

Intracapsular Cataract Extractions	No.	Percentage
	894	100
No post-operative complications attributable to any abnormality of the position or the state of the vitreous	483	54
Marked prolapse of the vitreous into the anterior chamber without rupture	16	2
Late post-operative rupture of the vitreous face	206	23
No evidence of adhesions	133	15
Adhesions seen subsequently	73	8

It is hoped to continue the study of the comparative frequency and severity of vitreous hernia in intracapsular extractions and those performed with the erisophake and with the forceps.

Summary

The Harrington erisophake is described together with a technique for its use and the experiences encountered in 50 cases of cataract extraction by this method.

A note is made of the importance of vitreous herniation in intracapsular extractions.

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CASE NOTES

TOXOPLASMIC CHOROIDO-RETINITIS IN THE ADULT*

BY

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NUMEROUS cases of toxoplasmosis of congenital origin have been reported since the work of Sabin and Olitsky (1937) and the case of Wolf, Cowen, and Paige (1939). Sabin (1950) has stated that there is no conclusive evidence that choroido-retinitis as a manifestation of toxoplasmic infection can occur after birth. Wilder (1952), on the other hand, has found organisms morphologically similar to toxoplasma in pathological sections of adult human eyes with granulomatous choroido-retinitis. Duke-Elder, Ashton, and Brihaye-Van Geertruyden (1953) have reviewed the recent literature on the subject, and have themselves reported a case of granulomatous choroiditis in which the vision was destroyed, and in which secondary glaucoma eventually necessitated the excision of the eye. The histological diagnosis of chronic granulomatous choroido-retinitis, probably tuberculous in origin, was made. 21 months later, in view of Wilder's findings, the sections were re-examined, and crescentic structures morphologically indistinguishable from toxoplasma were found. Koke (1953) reports the first case in which active choroido-retinitis probably due to toxoplasmosis was observed in an expectant mother who 2 weeks later gave birth to a female child with extensive intra-ocular disease, intra-cranial calcification, and positive serological tests for toxoplasmosis.

The present report provides further evidence that a primary choroido-retinitis can occur in the adult as a result of toxoplasma infection.

Case Report

A man, aged 35 years, first came under observation in November, 1951, when he was referred by his general practitioner to the Out-Patients' Department at Moorfields on account of active choroiditis of 2 weeks' duration. The patient's own history was of a black spot in the right field of vision for a fortnight before the examination. There was no previous history of any eye trouble nor of any interference with vision.

Examination.—In the right eye the anterior segment was normal, and there were no cells in the retrolental space. There was a fine vitreous haze, and a small woolly patch of active choroido-retinitis above the macula, of about a half disc diameter in size. The visual acuity was 6/9 unaided.

The left eye was normal with visual acuity 6/6 unaided.

Diagnosis.—The patient was admitted to hospital for investigation and treatment. *X* rays of the sinuses and chest were negative. The Wassermann reaction, gonococcal

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complement-fixation test, white blood count and differential count, and erythrocyte sedimentation rate all gave negative results. A toxoplasma serum test gave a positive result for both the cytoplasm modifying dye test (1:30) and complement-fixation test (1:20).

Treatment.—Local treatment with atropine and short-wave diathermy was given, followed by a course of systemic cortisone, given first by intra-muscular injection and then by mouth. The patient was discharged from hospital on December 13, 1951.

Subsequent Progress.—On discharge, the unaided visual acuity was only 6/24 in the right eye. A month later the corrected visual acuity was recorded as 6/18. At this stage, treatment with short-wave diathermy was discontinued, but the atropine was prescribed for a further month.

Four months after the onset, the visual acuity of the right eye had recovered to 6/9 corrected ($+1.00\times90°$), the vitreous was clear, and the choroido-retinal lesion appeared as a healed scar just above the macula (Figure).

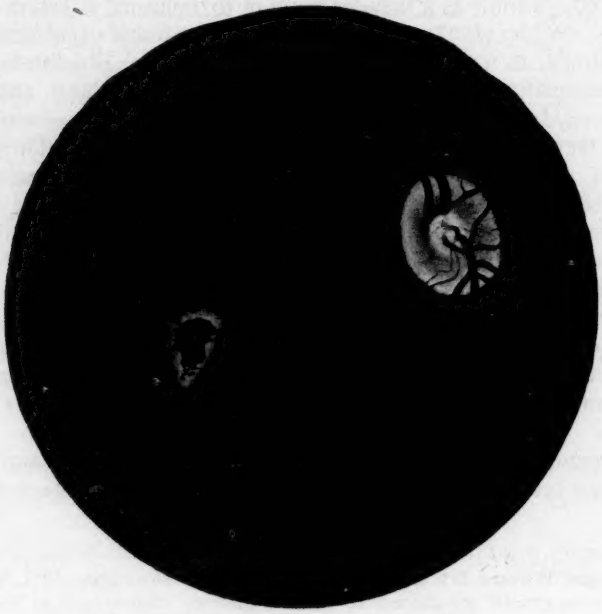

FIGURE.—Healed choroido-retinitis near right macula.

Follow-up.—A year later, on routine follow-up, further blood was taken for toxoplasma serum tests, and a cytoplasm modifying dye test titre of 1:800 was found, with a complement-fixation titre of 1:40. An *x* ray of the skull taken at the same time showed no abnormality.

The Table (opposite) shows titre values for both serological tests, taken at monthly intervals since the high titre was first observed. The serial tests show a gradual fall in titre for both the cytoplasm modifying dye test and the complement-fixation test over the period of observation.

A periodic examination of the right fundus has shown no change in the choroido-retinal lesion since it was recorded as healed in March, 1952.

TABLE

Date	Cytoplasm Modifying Dye Test	Complement-Fixation Test
November, 1951	1:30	1:20
March, 1953	1:800	1:40
April, 1953	1:330	1:16
		1:32 (partial)
May, 1953	1:160	1:32
June, 1953	1:120	1:40
July, 1953	1:80	1:120

Conclusions

A case of choroido-retinitis in an adult, probably due to toxoplasmosis, is recorded. The evidence is both clinical and serological. There was no previous history of eye disease nor had the patient observed the symptoms of which he complained at the time of examination. A localized patch of active choroido-retinitis was seen when the patient was first examined, and this subsequently became a healed, quiet lesion. A titre level for toxoplasma of 1: 30, which is not regarded as a significant level in the patient's age group, rose later to 1: 800, a highly significant figure, during the period of follow-up. This has since gradually fallen towards the low titre level of the original test. The possibility of an anamnestic reaction to account for the rise in titre must not be overlooked, but there is nothing in the patient's history to confirm that any significant febrile illness occurred in the interval.

I should like to express my thanks to Mr. J. E. M. Ayoub for kindly allowing me to report this case, to Dr. Norman Ashton for his assistance, to Professor C. P. Beattie for carrying out the toxoplasma tests, and to the Medical Committee of the Moorfields Branch of the Moorfields, Westminster and Central Eye Hospital for permission to publish the findings.

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UVEAL LYMPHOSARCOMA*

BY

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LYMPHOMATOUS tumours involving the lids and orbit have been recognized and repeatedly reported in the literature for many years; intra-ocular involvement on the contrary is rare if the lymphomatous infiltrations associated with lymphatic leukaemia are excluded. Kukán (1935) and Triebenstein (1920) have each described a case of uveal lymphosarcoma complicated by secondary glaucoma, and other isolated cases of ocular lymphoma have been reported by Hartshorne (1922), McGavic (1943), and Cooper and Riker (1951). Further indication of the comparative rarity of the condition is that, in a series of 67 cases of orbital lymphoma examined by Heath (1948), only three showed involvement of the globe. Of the biopsies of lymphomatous tumours examined in the pathology department at the Institute of Ophthalmology during the past 10 years, only one recent specimen showed evidence of intra-ocular involvement; since this case proved to be of especial clinical and pathological interest in that both orbital and intra-ocular tissues were involved, it has been made the subject of this report.

Case Report

A female aged 59 first attended the out-patient department on May 31, 1951, complaining of redness and severe pain in the left eye of one week's duration. She gave a history of sudden loss of vision in the eye 2 years previously but had been otherwise quite free of symptoms up to the time of the present complaint.

Examination.—The left eye was intensely injected and there was a diffuse and marked corneal oedema. The intra-ocular tension was much increased to digital palpation and the vision was reduced to a bare perception of light but no details of the posterior corneal surface, iris or fundus were visible owing to the extreme corneal oedema. A tentative diagnosis of thrombotic glaucoma was made, and in view of the severe pain the eye was enucleated. On removing the globe it was found that the posterior portion of the orbit was filled with a white gelatinous mass of tissue which histologically consisted of a dense aggregation of closely packed lymphocytes, which not only closely adhered to the posterior sclera of the globe, but also extended into the subarachnoid space and optic nerve (Fig. 1). Sections of the globe itself showed that the choroid, and to a lesser extent the iris and ciliary body, were densely infiltrated with small lymphocytes among which a few immature cells were visible (Fig. 2). The lymphocytic infiltration in the posterior choroid reached massive proportions and the normal choroidal structure was completely destroyed (Fig. 3). The degenerate retina was totally detached and a subretinal exudate was present.

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FIG. 1.—Subarachnoid space invaded; optic nerve shows scattered lymphocytic infiltration. ×15

FIG. 2.—Ciliary body and choroid show dense lymphocytic infiltration. Aggregations of closely packed lymphocytes in retro-orbital space adherent to posterior sclera. ×3.5

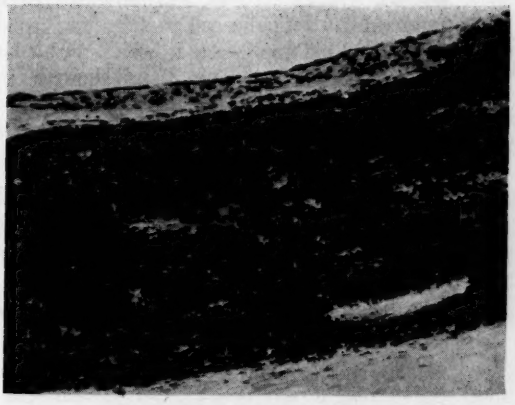

FIG. 3.—Choroid densely infiltrated by mass of lymphocytes. ×90

The histological appearance was consistent with the diagnosis of either a primary choroidal lymphosarcoma with extra-ocular extension or a combined ocular and orbital lymphosarcomatous infiltration as part of a generalized lymphosarcomatosis.

Laboratory Investigations.—Repeated blood counts and a sternal puncture showed no abnormality.

Follow-up.—After an uneventful recovery, a course of deep *x*-ray therapy was given to the socket and the patient was discharged. She has been examined at intervals since her discharge from hospital and up to the present time there is no evidence of recurrence in the socket or of any systemic lymphosarcomatous involvement.

Discussion

As is well known, proliferation of lymphoid tissue is a common manifestation of chronic infection and as such may occur in almost any part of the body, but the early pathological differentiation between the hyperplastic and the neoplastic lymphoid proliferations is in many cases a matter of extreme difficulty, the histological line of demarcation between them being but poorly defined in the initial stages. Thus early biopsy of a lymphoid nodule may show an apparently benign proliferation of lymphoid tissue, and only in the later stages may the occurrence of a generalized lymphadenopathy or of blood changes of a leukaemic type reveal the truly malignant nature of the condition.

In recent years many attempts have been made to classify the group of closely related tumours arising from the cellular elements of the lymphatic system, but a most unfortunate confusion of terminology has resulted. The classification of neoplastic disease generally is founded upon cytological factors, and rests primarily upon the identification of the predominating cells and their differentiation.

It is upon this basis that Lumb (1952) has introduced a pathological classification of lymphoid tumours which, although allowing for much histological overlap, constitutes a practical scheme of subdivision conforming with both pathological and clinical characteristics. In Lumb's classification four groups are defined according to the identity of the predominant cells:

(1) Predominant lymphocytic differentiation (lymphocytic lymphoblastic lymphoma, lymphosarcoma, and follicular lymphoma).
(2) Predominant reticulin cell proliferation (reticulin cell sarcoma).
(3) Mixed cell differentiation in which occur lymphocytes, reticulin cells, and other cells formed by the primitive mesenchymal cell (Hodgkin's disease and lympho-reticular lymphoma).
(4) Anaplastic sarcomata (including all the anaplastic varieties of the above three groups).

Within each of these groups a fairly well differentiated picture may be found, and the disease may correspondingly vary in severity from a benign stage, with a survival prognosis of many years, to an intensely malignant form, with a prognosis of only a few months. It is now widely accepted that the appearance of an isolated lymphoma anywhere in the body may be

the precursor of a generalized lymphomatous dissemination; and, although such solitary lesions not uncommonly occur, it must be emphasized that these often constitute a transient phase which will eventually progress into a generalized process if the patient survives long enough.

This fact is well illustrated by a case cited by Feinstein and Krause (1952) of a conjunctival lymphoma which was kept under observation for 18 years before it produced systemic manifestations; further confirmation is provided by Heath (1948), who in his review of conjunctival lymphomata, found that, even when the lesions were small and immediately removed, 50 per cent. of the cases ultimately showed evidence of general disease.

The long-term prognosis of isolated ocular lesions would, therefore, appear to be uncertain, but lymphomata are characteristically radio-sensitive and the immediate results of early combined surgical removal and *x*-ray therapy are usually good. An assessment of the probable ultimate prognosis in such cases will be possible only after an extended and extensive follow-up has been carried out.

Summary

A case of uveal and retrobulbar lymphosarcoma associated with glaucoma is reported, and the pathological classification and prognosis of ocular lymphoid tumours are discussed.

I should like to express my thanks to Mr Frank Law both for his permission to publish this case and for his invaluable advice, and to Dr. Norman Ashton for his great interest and help in preparing the report.

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DENIG'S OPERATION FOR TRACHOMATOUS PANNUS*†

BY

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Case Report

A married female, aged 34, came to the London Jewish Hospital over 22 years ago with trachoma and pannus crassus of the right eye. Treatment by the ordinary methods was unsuccessful and consequently the operation of transplanting mucous membrane of the lip on to the eye (Denig's operation) was performed. For cosmetic reasons the mucous membrane graft was placed 2 or 3 mm. above the corneal limbus so as to ensure that the upper lid would always cover it.

Within a few days the eye became quiet and it had remained so until she presented herself some 6 months ago. The graft was still freely movable and in perfect union with the bulbar conjunctiva. It still remained mucous membrane of the lip, and a few large blood vessels superficial to the substantia propia of the cornea were still visible in the cornea. The preservation of a mucous membrane graft (proved histologically,) for 22 years is a record in the literature of this subject.

Histology.—A section of the graft and a fragment drilled with a trephine through the whole thickness of the lid (excluding the skin surface) were sent to the Institute of Ophthalmology, where they were examined by Dr. Norman Ashton and Dr. C. H. Greer who have submitted the following report:

> Section of the graft shows a strip of tissue covered partly with conjunctival epithelium and partly with stratified non-keratinizing epithelium, the junction between the two being sharply marked. Very numerous goblet cells are present in the conjunctival epithelium, while the stratified portion exhibits marked and irregular thickening due to swelling and cytoplasmic vacuolation of the prickle cells. No inclusion bodies were seen. The subepithelial tissue throughout shows fragmentation of collagen, new capillary formation, and a diffuse infiltration with plasma cells, indicating prolonged mild inflammation.
>
> Section of the drilled fragment shows dense fibrous tissue embracing a few acini of atrophic lacrimal tissue. No inclusion bodies were seen.

Discussion

This case raises a series of problems:

(1) *What are the indications for Denig's operation*?—Denig (1911) used the mucosa of the lip because he believed it could not be invaded by trachoma (Pines, 1948). Since the mucosa does not possess lymphatic tissue it would provide an impenetrable barrier protecting the cornea from invasion by trachoma. This postulates that the pannus results from invasion of the cornea by extension from the conjunctiva, but it is now known that the cornea can itself be infected by trachoma and in this case the operation would be of no use. Moreover Poleff and Viennot-Bourgin (1950) were successful in infecting the mucosa of the lip with the virus of trachoma.

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†The detailed history of this case cannot be given because the hospital records were destroyed by enemy action.

Alternatively it has been held that the pannus arises from irritation of the cornea by the inflamed upper lid, so that by interposing a barrier of healthy mucosa the cornea would be protected. This theory of the causation of pannus has been much criticized, but a case shown at the Ophthalmological Section of the Royal Society of Medicine in 1946 makes one think again:

> A man of over 75 years of age was treated by *x* ray for an epithelioma of the left upper lid in 1943. In October 1946 he presented himself with an inflamed left eye and pannus crassus. There were signs of old healed trachoma in the right eye. Denig's operation was performed and the graft took well, but the pannus recurred within a few months. A deformity of the left upper lid was noticed in 1950, and when this was excised in 1951 it proved to be a basal carcinoma.

It may be asked whether the pannus was merely a coincidence or was caused by the friction of a slowly growing tumour.

Arkin (1926) thinks that there are two forms of pannus, one secondary to an infection of the conjunctiva, and the other secondary to a primary infection of the cornea. Be this as it may, the clinical indications for Denig's operation are that the chief lesion must be pannus crassus, and that the eye must not be much inflamed. The trachoma must be relatively inactive and the beneficial effect of the operation may be due to the deep peritomy which the performance of the operation entails, the subsequent formation of a deep scar creating a barrier.

Denig's operation is suitable only therefore for the third or fourth stage of trachoma, according to the classification of MacCallan (1936), but there is no method by which the intensity of the remaining infection can be gauged.

(2) *How is one to know whether the patient is cured*?—Spassky (1951) endeavoured to determine this by drilling (with a trephine) through the whole thickness of the upper lid (excluding the skin). If the specimen shows hyperplasia only, then the patient is cured. If inflammatory lesions are still seen, then the trachomatous process is still active. In our case the specimen shows mild inflammation, and the cure is therefore not complete.

(3) *What is the fate of the graft*?—This case shows clearly that the graft remains lip mucous membrane.

I am indebted to Mr. A. Harold Levy for his assistance in the case and for permission to publish it, and to Dr. Norman Ashton and Dr. C. H. Greer of the Institute of Ophthalmology for the histological report.

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Brit. J. Ophthal. (1954) **38**, 188.

APPLIANCES

LID RETRACTOR FOR CATARACT EXTRACTIONS*

BY

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THIS type of lid retractor is suggested for intra-capsular work, as it has been found to provide better access to and less pressure on the eyeball, than the usual specula, superior rectus, or lid sutures.

The upper lid retractor is made from a wire paper-clip and No. 3 silk. The shape of the paper-clip can easily be slightly altered to suit the individual patient, at the time of operation. A single lid suture is used to retract the lower lid. Spencer Wells's or Joll's haemostats, clipped on to the loose ends of the silk, provide sufficient weight to hold the lids open if facial nerve and retrobulbar injections have been given. I insert a superior rectus suture, although it is seldom needed if a little procaine has been injected into the superior rectus.

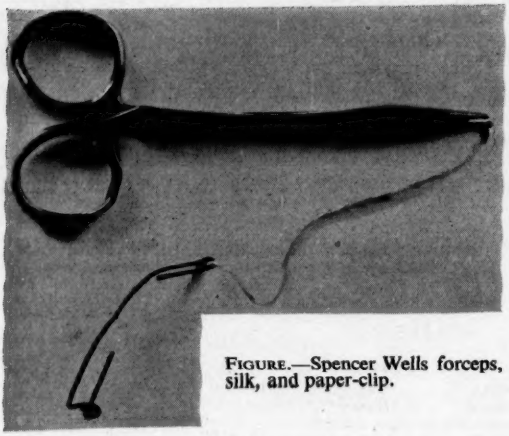

FIGURE.—Spencer Wells forceps, silk, and paper-clip.

I do not like giving the whole retrobulbar injection from above as it seems to give more pain and in some cases has a greater tendency to produce retrobulbar swelling than when given from below.

It is obvious that this method of lid retraction is unsuitable for the occasional patient who has to be operated upon in a sitting position.

The idea of using paper-clips for this purpose arose during the recent war, when the availability of large numbers of sterilized lid retractors saved much time in the examination of eye casualties.

I am indebted to Dr. J. R. Hamerton for the accompanying photograph.

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KERATOPLASTY CLAMP*

BY

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OPHTHALMIC surgeons and instrument manufacturers have been jointly responsible for turning out a number of useful keratoplasty instruments; some of these are difficult to obtain either because their cost is prohibitive or because exchange regulations do not permit their importation. The appliance described below is not a new " gadget " but a very old instrument put to a new use. In fixing a corneal graft to the host by direct sutures the graft has to be held in a manner least damaging to the graft while the sutures are being placed. Arruga's box forceps in various sizes are used by many surgeons, but to many of us scattered over the globe this additional armamentarium amounts to a luxury and also, in lamellar keratoplasty, shapes other than circular may have to be employed in which case Arruga's box forceps are unsuitable.

I have used the following appliance and find it satisfactory. Two lengths of rubber tubing about 1½" long are slipped over the blades of a fixation forceps (Elschnig's preferably) leaving the teeth bare (Fig. 1).

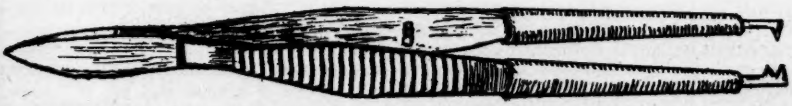

FIG. 1.—Elschnig's fixation forceps with rubber sleeves on the two blades.

This imitation of gastric and intestinal clamps constitutes the whole gadget. In transferring the graft on to the "clamp" care is taken to see that the epithelial side is towards the male blade of the forceps, that on which the manufacturer's name is inscribed. This practice will guard against the wrong aspect of the graft being apposed to the host. Small grafts could be clamped by the distal portions of the tapering rubber-sleeved blades, and larger grafts may be held by the proximal portions. Fig. 2 shows how the graft is held and the sutures passed. The thumb and index finger are used to keep the blades apposed. Any number of sutures can be placed successively by rotating the graft.

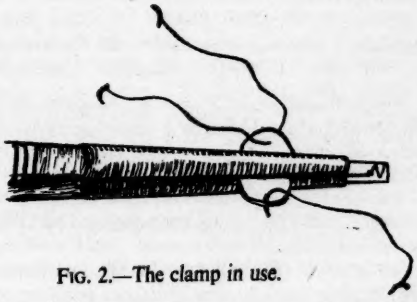

FIG. 2.—The clamp in use.

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BOOK REVIEWS

The Lateral Geniculate Nucleus and Visual Histophysiology. By G. L. Walls. 1953. Pp. 100, 13 figs, bibl. University of California Press, Los Angeles. ($1·25.)

This is very detailed and important investigation into the reason for the lamination of the lateral geniculate body (nucleus).

It was Le Gros Clark's suggestion that the three-fibre unit of the optic nerve had to do with colour vision (with which indeed Walls does not agree) which gave the main impetus to the writing of this monograph. Walls sets the problem as follows:

Lamination, as a structural feature in neuro-anatomy, is more thoroughly characteristic of the visual system than of any other that comes to mind. The retina itself is laminated, whether richly and cleanly as in lizards and birds, or simply and untidily as in lampreys and turtles. The superior colliculus or optic lobe is likewise comprised of interleaved layers of grey and white matter. The visuosensory cortex (Area 17), with its Gennari stripe, is even more elaborately laminated than is the cortex as a whole.

The mammalian lateral geniculate nucleus is often also conspicuously laminated. But the significance of the laminary plan here is entirely different from what it is elsewhere. In the retina, in the superior colliculus, and in the cortex, most of the cells which stand at different levels are very different in their functions. The neat ordering of their bodies into layers, mainly according to type, makes room for intervening synaptic beds in which specific activities are carried on. Community of function results in a sort of micro-neurobiotaxis, and laminations are probably inevitable. With the LGN, there are no obvious rewards for lamination. The fibrous interlaminae are axon mats, not synaptic beds – and indeed, there is no proved instance of any intercommunication from lamina to lamina, across interlaminae, in the LGN of any mammal.

After a very wide search for evidence the author comes to this conclusion:

The three ipsilateral, or the three contralateral, laminae in Man do all differ among themselves, I am sure. But their differences are not so simple as to be within one modality like the differences between red, green, and blue. I have characterized the pile of laminae as a pile of " maps ". I can now carry that analogy a step farther and assert that–say–human laminae No. 1, No. 4, and No. 6 are related to each other as are three maps of the same country, one of which is geodetic, a second climatological, and the third agricultural. Just as three maps are required to keep such kinds of information apart and intelligible, so also a mammal with highly differentiated vision requires a multiplicity of genicular maps if the cortex is to be able to make full use of the classified information the retina sends toward it. I consider this analogy so apt that I shall not mind if my theory comes to be known as " the cartological theory of geniculate lamination ".

Parson's " Diseases of the Eye ". By Sir Stewart Duke-Elder. 12th ed., 1954. Pp. 606 465 figs, 22 col. pl. Churchill, London. (42*s*.).

The 12th edition of Parson's " Diseases of the Eye " has been brought up to date by Sir Stewart Duke-Elder by a complete revision and re-presentation of large parts of the previous edition. This has been necessitated by recent advances in aetiology, pathology, physiology, treatment—medicinal and operative—, and anaesthesia.

The book is well printed on good paper. The illustrations are of a high order, those of clinical conditions having been changed and many new figures added. The colour printing is well executed and very natural. With a full index, reference is an easy matter. The use of a fair amount of small type for the less important subjects enables the book to remain within what some foreign countries consider to be " pocket size ".

The work is very readable and will be of the greatest assistance to students, general practitioners, and junior ophthalmic surgeons. It seems almost presumptuous to say that it can be highly recommended.

Lyle and Jackson's Practical Orthoptics in the Treatment of Squint. By T. Keith Lyle and M. Walker. 4th edition, 1953. Pp. 371, 195 figs (including 3 col. pl.). Lewis, London. (63*s*.)

It is a far cry from the slender volume of the first edition of Lyle and Jackson's "Practical Orthoptics in the Treatment of Squint" to the present text-book, fresh from the publisher, which forms the fourth edition. There are many changes to mark this edition from its immediate predecessor; the abolition of "authorized economy standards" has led to an increase in its pages from 271 to 371; the work of Miss Salsbury and Miss Billinghurst has been taken up and developed by Mrs. Marianne Walker; there are 44 additional illustrations and new chapters on ocular neurosis and nystagmus; advice is given on the management and layout of an orthoptic department and the photo-frontispiece of the old orthoptic clinic in the basement of the Westminster Branch of Moorfields is replaced by a new one of the well-windowed and spacious department now existing on the first floor. The price of the volume has also increased (from 35 to 63*s*.).

The book is intended primarily for orthoptic students, but the constant demand for it from the medical lending libraries and the rapid sale of new editions suggest that it serves a wider purpose and need. This is not altogether surprising for the text fulfils the promise of its title. It is written always from the practical point of view, and such theoretical argument as exists is demonstrated and its lessons driven home by recourse to actual case histories and clinical examples. The production of this work represents hours and days of precise and sustained observation in the out-patient department, and its gradual evolution with the years is the result of the weighing and sifting of clinical evidence, and the establishment of firm principles with an open-mindedness towards new ideas.

The ophthalmic surgeon who finds himself divorced geographically from the personal advice of his more experienced colleagues and who is confronted with a problem of extra-ocular imbalance will almost certainly find a similar case described in this new volume and will be able to read, in detail, how to investigate it. A comprehensive practical guide is clearly the author's aim and the growth of the text-book from the primer of 1937 to the standard work of 1953 must provide him, if he has time to reflect, with a source of deep satisfaction. It is a pleasure for his friends and pupils to note on the title page that the State has recognized his good works and we wish the new edition the success it deserves.

Test Types (Sehproben nach A. Roth). By P. A. Jaensch. 5th edition, 1953. Pp. 11, 8 test types. Georg Thieme Verlag, Stuttgart. (DM. 7·50.)

According to Professor Jaensch, there has for some time existed very little choice of satisfactory Distance or Reading Types in Germany; this 5th edition of Roth's Types should therefore be welcomed there. Of the seven distance charts, which are well printed on paper, Chart No. 7 consists of "E"s and Landolt's broken rings, the remainder contain figures or letters or both. Professor Jaensch has taken particular care that this new edition should comply as accurately as possible with the requirements of Snellen. Serif letters are employed as being more readily understood in Germany, and the charts are designed for use at 5 metres. These two departures from present-day British practice will limit their value in Great Britain. The near types are of the Snellen variety, long outmoded in Great Britain. The printing of the German texts is, however, excellent.

NOTES

Irish Ophthalmological Society

The Annual Meeting of the Irish Ophthalmological Society will be held in Dublin on April 29 and 30, and May 1, 1954.

The Montgomery Lecture, entitled "Some Recent Contributions to the Diagnostic Problem of Glaucoma" will be delivered by Professor Bietti, Parma, Italy.

League Against Trachoma

Chibret Gold Medal, 1955

The Chibret Gold Medal (value 200,000 francs) will be awarded for the third time during the General Assembly of the League against Trachoma which will be held in Paris in 1955 during the Congress of the French Ophthalmological Society.

Entrants may be trachomatologists of any nationality. Work submitted should follow this order: clinical, social, preventive, medical and surgical treatment. Entries must be written in French and must be sent before January 1, 1955, to the Secretary-General, Dr. J. Sédan, 94 rue Sylva belle, Marseille, France, from whom further details may be had on application.

V Pan-American Congress of Ophthalmology

The V Pan-American Congress of Ophthalmology will be held in Santiago de Chile in February, 1956. A full programme has already been planned and those interested should write to the Secretary-General, Dr. René Contardo, Huérfanos 930-OF. 74, Santiago de Chile, Chile.

Birmingham and Midland Eye Hospital

Postgraduate Course in Industrial Ophthalmology

This course, which will be held from July 19 to 23, 1954, is designed for ophthalmologists and industrial medical officers, but is open to all medical practitioners. It will include clinical demonstrations, lectures on industrial diseases and injuries, and visits to local factories and a coal mine.

Further details may be obtained from the Director of Research, Birmingham and Midland Eye Hospital, Church Street, Birmingham, 3.

OBITUARY

Our readers will be sad to learn of the sudden deaths of two of our colleagues, both of whom were in the prime of their careers and were widely known throughout the world, and especially in Great Britain, both for their professional ability and their personal qualities.

Dr. Daniel B. Kirby died unexpectedly in the last days of December, 1953, at his home near New York. Born in Cleveland, in 1891, educated at the Western Reserve University and an interne at the Toronto General Hospital and the Bellevue Hospital, New York, he entered practice in this city in 1923 in association with John M. Wheeler. He served in the U.S. Navy in the first World War, and became Director of the Department of Ophthalmology of the Bellevue Hospital, and Professor of Ophthalmology at New York University. He was one of the best known figures in ophthalmic surgery in the United States, and his book *The Surgery of Cataract* (1950) was a unique contribution to our knowledge of this subject of which his practical experience was immense. He was widely known and had a large circle of friends outside the U.S.A., and his kindly personality as well as his professional stimulation will be missed particularly in Great Britain. Our sympathies are extended to his wife and four daughters.

Dr. Bernardo Semadeni died suddenly on December 30, 1953, in his 47th year, following an operation after a prolonged illness. Born in 1906, he graduated at the University of Zürich where he remained as one of Vogt's assistants from 1932–1936, undertaking during this period extensive studies on the aetiology of radiational cataract. Thereafter he returned to Davos where eventually he became chief of the Eye Clinic of Guardaval. In 1941 he won the Vogt Prize with a comprehensive study on ocular filariasis, and as President of the Swiss Ophthalmological Society he represented his country at the XVI International Congress of Ophthalmology in 1950. He also has left a wife and family whom many of us know; and his professional enthusiasm and charming personality will be missed among a large circle of friends far beyond the bounds of Switzerland.